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A prepackaged pumping and storage system for the collection and temporary containment of hazardous land spills was designed and two models developed. Each model includes a pump, hoses, furled self-deploying 26,500 ℓ (7000 gal) capacity plastic bag array all mounted on a pallet for transporting by pickup truck. The first model also includes batteries, electric motor, and starter, while the improved second model carries a gasoline-powered pump engine and fuel. Nominal pumping rates are 200 and 300 ℓpm (50 and 80 gpm). Commercially available components were specified. The effect of pump speed, fluid viscosity, and vapor pressure on flowrate were determined. Polyurethane diking possibilities were also investigated. System demonstrations are described.

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EMERGENCY COLLECTION SYSTEM FOR SPILLED HAZARDOUS MATERIALS

by

Ralph H. Hiltz
Ferdinand Roehlich, Jr.
MSA Research Corporation
Evans City, Pennsylvania 16033

Contract No. 68-03-0206

Project Officer

John E. Brugger
Oil and Hazardous Materials Spills Branch
Industrial Environmental Research Laboratory (Cincinnati)
Edison, New Jersey 08817

INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

The subject of this report is "Emergency Collection System for Spilled Hazardous Materials." It represents an accounting of a development program whose primary objective was the evolution of a pumping and temporary storage unit for field use. The end result of this program was the design, fabrication, testing, and demonstration of two operable units. Users who may find this report valuable are municipal and private organizations who may be called upon to control a hazardous material spill. These would include fire and rescue squads, pollution control teams, National Guard and local militia. The field units described herein are readily fabricated from commercially available components. The report may also be of value to research users who may wish to further extend the capabilities of these units by utilizing specifically-designed components. Further information on the subject may be obtained by contacting the Industrial Environmental Research Laboratory.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

A prepackaged pumping and storage system for the collection and temporary containment of hazardous land spills was designed and two models developed. Each model includes a pump, hoses, furled self-deploying 26,500 ℓ (7000 gal) capacity plastic bag array all mounted on a pallet for transporting by pickup truck. The first model also includes batteries, electric motor, and starter, while the improved second model carries a gasoline-powered pump engine and fuel. Nominal pumping rates are 200 and 300 ℓpm (50 and 80 gpm). Commercially available components were specified. The effect of pump speed, fluid viscosity, and vapor pressure on flowrate were determined. Polyurethane diking possibilities were also investigated. System demonstrations are described.

This report was submitted in fulfillment of Contract No. 68-03-0206 by MSA Research Corporation, Division of Mine Safety Appliances Company, Evans City, Pennsylvania 16033, under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period November 10, 1972 to December 31, 1975, when the work was completed.

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SECTION 1

INTRODUCTION

A program was undertaken for the Industrial Environmental Research Laboratory to develop and construct an emergency collection system for spilled hazardous materials. Specifically, the program involved the development, fabrication, demonstration and evaluation of two working systems for transferring hazardous liquid chemicals from a diked or sumped pool or from a damaged transportation vehicle to a temporary storage bag. The original system developed consists, essentially, of a folded four-part, 26,500 ℓ (7000 gal) bag; a pump; 30 m (100 ft) of hose; and a battery power supply. The second system is a modified version of the original one utilizing a gasoline engine-powered pump and featuring greater operating efficiency.

Included in this report are descriptions of the design study, component selection and assembly, and the operation and performance testing (which were conducted as part of the development of these systems). In a later stage of the program, attempts were made to improve the adhesive properties of polyurethane foam for use as a diking substance to contain hazardous spills.

SECTION 2

CONCLUSIONS

The research and development project described in this report resulted in the construction of two functioning emergency collection systems for spilled hazardous materials. Conditions that could be encountered in field operations of the system were carefully considered in the design phase of the project. These conditions include (1) possible terrain problems, (2) generation of static electricity, (3) operating and servicing accessibility, (4) portability, and (5) chemical resistance. The selection and assembly of system components was described. System operation has been detailed in two operating manuals (Appendices A and B), which were prepared following the performance tests of the units.

The original requirements for size, weight, operability and collection capacity have been essentially met. Pumping capacity and portability were improved considerably in the second unit. Polyurethane dikes were effective in spill containment except on wet, smooth surfaces.

SECTION 3

RECOMMENDATIONS

The collection systems developed under this program have been tested under controlled conditions. It remains to be seen how effectively they function under actual field conditions. Hence the first recommendation is to employ the systems at accidental spill sites.

Each commercially available system component was selected on the basis of its ability to function in the system. Some restrictions, such as size and weight, were imposed in order to increase portability of the systems. For example, a 5.08 cm (2 in.) hose was selected instead of a 7.62 cm (3 in.) in order to limit the size of the hose reel. Hence the second recommendation is to consider alternate components for future system designs in order to achieve desired operating characteristics not present in these systems.

SECTION 4

DESIGN STUDY

The design philosophy employed in the development of the first model of the emergency collection system was based on the following principles:

A. Meeting established or modified specifications (design criteria).

B. Providing adequate safety features.

C. Providing adequate access for system maintenance.

D. Reducing system operating complexity.

E. Providing for application flexibility.

SYSTEM DESIGN CRITERIA

Size and Weight Restrictions

The foremost requirement was that the entire system be transportable by small truck, pickup, van, or dual-wheeled railroad vehicles. Originally this requirement was thought to impose size and weight limitations of 1.2 m (4 ft) x 1.2 m (4 ft) x 0.6 m (2 ft) high and 450 kg (1000 lb). However these were found to be unnecessarily restrictive. Modified envelope limits for the first model were set at 1.2 m (4 ft) x 1.2 m (4 ft) x 1.2 m (4 ft) and weight limit at 550 kg (1200 lb) with the system pallet mounted. These limits were expanded for the second system to 1.2 m (4 ft) x 1.8 m (5.5 ft) x 1.2 m (4 ft).

Receiving Bag

The intent of the program was to devise a collection system for any hazardous material. Since no single material was available that could withstand all possible hazardous materials, the design philosophy was to select a bag material whose mechanical strength would be minimally affected by most materials during a short-term storage period.

The burst strength requirement of the bag is dependent on its volume and attitude of deployment (i.e., slope of hillside,etc.) as well as on the density or weight of the fluid to be contained within the bag. Here again the design philosophy was to specify a bag material burst strength which would be satisfactory for most materials rather than designing for a "worst case".

The size of the receiving bag, or combination of bags, was specified on the basis of the volume required to contain the contents of a standard highway tanker truck, i.e., about 26,500 ℓ (7000 gal). For purposes of portability and reliability, a combination of bags rather than one large bag was deemed more desirable. If the collected material in the bag could not conveniently be transferred on-location, a smaller bag could possibly be transported to another site. Also, if one smaller bag should rupture, the remaining bags in the group could still be utilized. Sausage-shaped bags were selected in order to minimize seam stresses which may become severe at the corners of a pillow-shaped bag. The latter type can be reinforced internally at additional cost.

Pumping System

The pumping system, which also must be compatible with most hazardous materials, had no real basis for sizing. It was arbitrarily decided that it be capable of transferring 26,500 ℓ (7000 gal) within a time period of about 2 hrs. Like the pump size, the power system also lacked a firm basis for size or type. Due to size and weight considerations, a one horsepower explosion proof electric motor was chosen as the power plant for the first model. This choice was decided in part by the fact that this was the minimum input consistent with the 13,200 ℓ/hr (3500 gph) set for the pump. For the second model, a more powerful but lighter weight three horsepower explosion-resistant engine was specified.

Power Supply

The power supply must be operable independent of any outside source. There were three alternatives -- electric power, liquid fuel power or a combination such as a diesel generator-powered electric motor. Batteries were selected to be the power source for the first model and gasoline for the second. The type and number of batteries employed are determined by the pump/motor requirements. The basic requirement is sufficient power to run the motor for two hours on a single battery charge. Other considerations also exist: size, weight, power-to-weight ratio, cost, etc.

An alternate power source was deemed desirable in situations where the systems would be required to operate longer than two hours,for example ,if additional bags had to be used to accommodate a rail tank car spill. Provisions were necessary to connect to auxiliary power such as a motor-generator set.

SYSTEM SAFETY

The overall system should be deployable on rough terrain by not more than two men and operable by a man in a protective suit.

The primary safety consideration is that of static electricity buildup during bag filling operations. Other areas of system safety included the possible explosion hazard created by electrical arcs or sparks and the general safe handling of corrosive or otherwise hazardous materials.

The quantity of electric charges generated by petroleum products flowing through pipelines is proportional to the 2nd power of the liquid's linear velocity in the pipeline. The presence of water or gas in the flowing liquid can increase the charging effect by a factor of up to 50. With hydrocarbon-water mixtures a maximum linear velocity of 1 m/sec is generally accepted as being safe. Products free from water or any other second phase may be pumped through pipelines at linear velocities of up to 7 m/sec.

Although pumping of oil products through pipelines may result in considerable electrification of the liquid, the operation in itself is not dangerous, since no explosive gas mixture is present in either the lines or the pumps. The situation becomes dangerous, however, when the pump or the filter discharges through a short line, or through a line made of insulating material into a tank containing an explosive gas mixture.

Specific methods of reducing static charge include the use of conductive hose to permit leakage of charge to ground, using a collapsed bag to prevent gases from forming in the headspace, proper sizing of hose to limit flow velocity, and placing of bag entry ports to prevent excessive splashing.

Electrical components which carry sufficient power to arc between contacts and possibly produce an explosion in a hazardous atmosphere should be encased in a hermetically sealed enclosure or in an approved explosion proof box. Such components include motors, motor starters, switches, etc.

OPERATING PROCEDURE

The system design was directed to simple operation. Routine deployment and operation of the system was not to entail complex maneuvers or personal contact with the spilled material. Hose connections should require no special tools or wrenches. Electrical controls should be explicit and require minimum operating instructions. The collection bag should be readily removable from its housing for rapid deployment. All components which require servicing or replacement should be located within the system in a manner which affords easy access by maintenance personnel.

SECTION 5

COMPONENT SELECTION

RECEIVING BAG

Material Selection

On the basis of discussions with both material and inflatable structures manufacturers, two types of materials, urethane coated or polyvinyl chloride coated fabrics, were deemed suitable for the first model. Both had good resistance to a broad range of chemicals, could be readily fabricated into a variety of shapes and were both currently in use for inflatable structures. There was some disagreement on which had the best puncture resistance but in each case it was considered adequate for the application. Urethane material was more expensive, but the final choice of a polyvinyl chloride material was based upon fabrication considerations of the selected design.

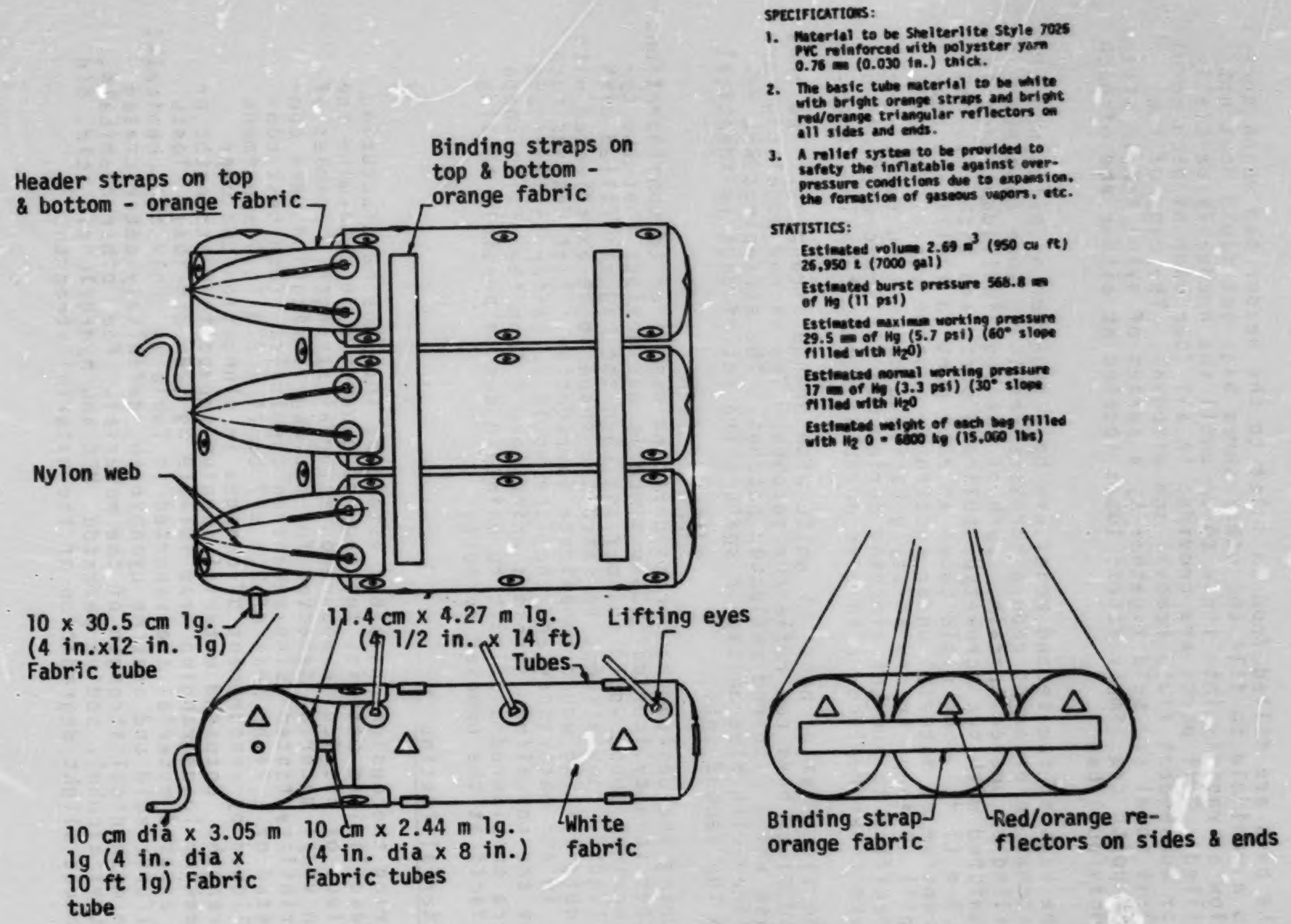
The material ultimately selected was a polyester fabric reinforced PVC, Shelterlite Style 7026, 0.75 mm (0.030 in.) thick. In this, as for all other materials and components, equivalents are available from other manufacturers. Selections were based upon cost, availability and, in some cases, prior experience.

For the second bag, a two-ply urethane coated nylon material was specified in order to improve abrasion resistance and low temperature capability (Shelter-Rite 7028, 0.8 mm [0.032 in.]).

Bag Design

The original bag design was evolved in cooperation with PICO, Division of Sargent Industries, of San Francisco, California. It reflects two considerations -- containing the fluid without rupture and a nonrolling condition with hillside deployment. The basic design is shown in Figure 1. It consists of three cylindrical bags fed by a fourth header bag. With this arrangement, the bag is stable on sloping ground.

Design burst strength is 0.75 atm (11 psi) with a stated working pressure of 0.39 atm (5.7 psi). This corresponds to a water filled bag on a 60° slope. In the filled condition the bag could not be held on a slope greater than 30°. Designing to 60° compensates for liquids of densities greater than water.


Header straps on top & bottom - orange fabric
Binding straps on top & bottom - orange fabric
Nylon web
10 x 30.5 cm lg. (4 in.x12 in. lg) Fabric tube
11.4 cm x 4.27 m lg. (4 1/2 in. x 14 ft) Tubes
Lifting eyes
10 cm dia x 3.05 m lg (4 in. dia x 10 ft lg) Fabric tube
10 cm x 2.44 m lg. (4 in. dia x 8 in.) Fabric tubes
White fabric
Binding strap-orange fabric
Red/orange reflectors on sides & ends

SPECIFICATIONS:

1. Material to be Shelterlite Style 7025 PVC reinforced with polyester yarn 0.76 mm (0.030 in.) thick.
2. The basic tube material to be white with bright orange straps and bright red/orange triangular reflectors on all sides and ends.
3. A relief system to be provided to safety the inflatable against overpressure conditions due to expansion, the formation of gaseous vapors, etc.

STATISTICS:

Estimated volume 2.69 m^3 (950 cu ft) 26,950 ℓ (7000 gal)

Estimated burst pressure 568.8 mm of Hg (11 psi)

Estimated maximum working pressure 29.5 mm of Hg (5.7 psi) (60° slope filled with H_2O)

Estimated normal working pressure 17 mm of Hg (3.3 psi) (30° slope filled with H_2O

Estimated weight of each bag filled with H_2O = 6800 kg (15,000 lbs)

Figure 1. Emergency collection system - fluid bag

The bags are filled from an inlet to the header bag which serves as a manifold to fill the other three bags but fluid does not flow as rapidly into these three until the header is partially filled. Exit ports are provided in all four bags of each model for subsequent fluid removal and disposal. The bags of the first model are held together by a series of nylon fabric straps. The ports are simply fabric tubes located at either end of each individual bag.

The bags of the second model are held together by belts and tie patches in order to reduce stresses resulting when bags are filled on uneven terrain. Each of the four individual bags is equipped with two screw-type bulkhead ports and with internal 0.3 m (1 ft) long rigid tubes at each port to facilitate back transfer of material under suction to another vessel following spill cleanup. Accordian-style bag interconnecting tubes were specified to prevent pinching during bag filling operations but were later replaced with more durable, straight-walled tubes.

The first set of bags is white with orange strapping. The ends and sides have red reflector patches. The second model bags are also white with red reflector patches. The strappings are replaced with blue belts. A spare third set of bags is identical to the second set.

During the design phase consideration was given to configurations other than cylindrical tubes since it was obvious that the cylindrical shape would not persist when the bag was filled with a liquid. Any attempt to match the shape to be experienced with liquid filling would complicate fabrication. Flat designs such as in air mattresses and the like would be easier to fabricate but the nonuniform stresses which result from the pillow shape were considered difficult to maintain due to possible peeling effects at the exposed corners.

Material Testing

During the design phase but extending into the manufacturing phase limited material testing was conducted to determine the effect of chemical exposure on material strength. Samples of the vinyl material selected for the bag fabrication were compatibility tested using seventeen chemicals. Each test consisted of a 24-hr soak of 2.5 x 7 cm (1 x 2.8 in.) specimens followed by measurement of changes in elongation and tear strength. Untested material samples showed tear strengths or breaking loads ranging from 101-119 kg (225-265 lbs). Tests on exposed material are reported in Table 1. Only two chemicals, sulfuric acid and acetone cyanhydrin, definitely deteriorated the mechanical strength of the material. Four other chemicals, methyl alcohol, sodium peroxide, MEK and hydrofluoric acid, did produce slight degradation of the material strength.

Table 1. TEAR STRENGTH OF VINYL FABRIC AFTER 24 HRS OF EXPOSURE TO CHEMICALS

Chemical	kg	lb
Phenol	142	312
Methyl Alcohol	92	203
Acrylonitrile	125	276
Benzene	127	281
Acetone Cyanhydrin	20	43
Xylene	135	298
Sulfuric Acid	5.9	13
Aldrin Toxaphene Group	98	216
Acetone	115	254
Nitric Acid	112	247
Ethyl Acetate	101	222
Sodium Hydroxide (30% solution)	92	202
Methyl Ethyl Ketone (MEK)	89	196
Hydrofluoric Acid	89	197
Hydrogen Peroxide (30% solution)	101	223
n,n-Dimethyl Formamide	119	263
Butyl Ether	134	296

Due to the cylindrical configuration not all seams could be heat sealed. The hemispherical ends were adhesive sealed. This was one consideration in fabric selection for the collection bag. With PVC adhesive joints would be equally chemical resistant with the base fabric. With urethane there was some concern as to the integrity of the adhesive bond under chemical attack.

At the time the second model was designed, a urethane coated nylon material became available which could be seamed or joined by heat bonding instead of adhesive bonding. This material also has good abrasion-resistance and low temperature rouge but is more costly than the PVC material.

PUMPING COMPONENTS

Pump and Motor

A self-priming centrifugal pump (ITT Marlow Model 1-1/2 HE 19 EL)was selected after careful consideration of the factors involved. A comparison of characteristics for three types of pumps -- rotary, straight centrifugal and self-priming centrifugal -- is presented in Table 2. Performance curves for the pump selected are given in Figure 2. At 1 HP and 2500 rpm it has a zero head capacity of 190 ℓ (50 gal)/min and a related suction lift of 7.6 m (25 ft).

Motor selection for the first model was based on the following factors:

a. Weight

b. Explosion proof housing

c. Compatability with pump

The motor selected is a Reliance Electric Company compound wound Model L263679 which is rated 1 HP at 2500 rpm with a 25-volt DC power supply. The effect of 24-volt operation instead of 25-volt is shown in Figure 2 (2400 rpm curve). Running current draw at 24-volts is 38.3 amps after an instantaneous start-up surge of about 550 amps. In a later modification the battery supply was rewired to produce 36-volt output to the motor. The resulting change in pump performance is shown in Figure 3.

For the second model the identical pump was employed mounted close coupled to a 3-HP explosion resistant gasoline-powered, one cylinder engine. This provided greater pump speed (see Figure 3) and reduced the weight of the system considerably by eliminating the batteries, motor starter and extensive support structure. An explosion-proof fuel container was selected for mounting on the pallet of the second model.

Table 2. PUMP CHARACTERISTICS* - COMPARISON

Characteristics	Rotary Pumps	Centrifugals	Self-Priming Centrifugals
Use on Suction Lifts (self-priming)	Excellent	Auxiliary equipment	Excellent
Pump Life	Poor on dry liquids	Excellent	Excellent
Quiet Operation	No	Yes	Yes
Pressure Relief	Bypass valve required	Unnecessary	Unnecessary
Resists Vapor Lock	Yes	No	Yes
Direct Drive Possible	No	Yes	Yes
High Capacity	No	Yes	Yes
H.P. Required	High	Low	Low
High Viscosity	Yes	No	No

* Added self-priming centrifugal advantages:

1. Ability to prime with suction lift
2. Ability to handle air
3. Ability to handle volatile and dry liquids such as gasoline

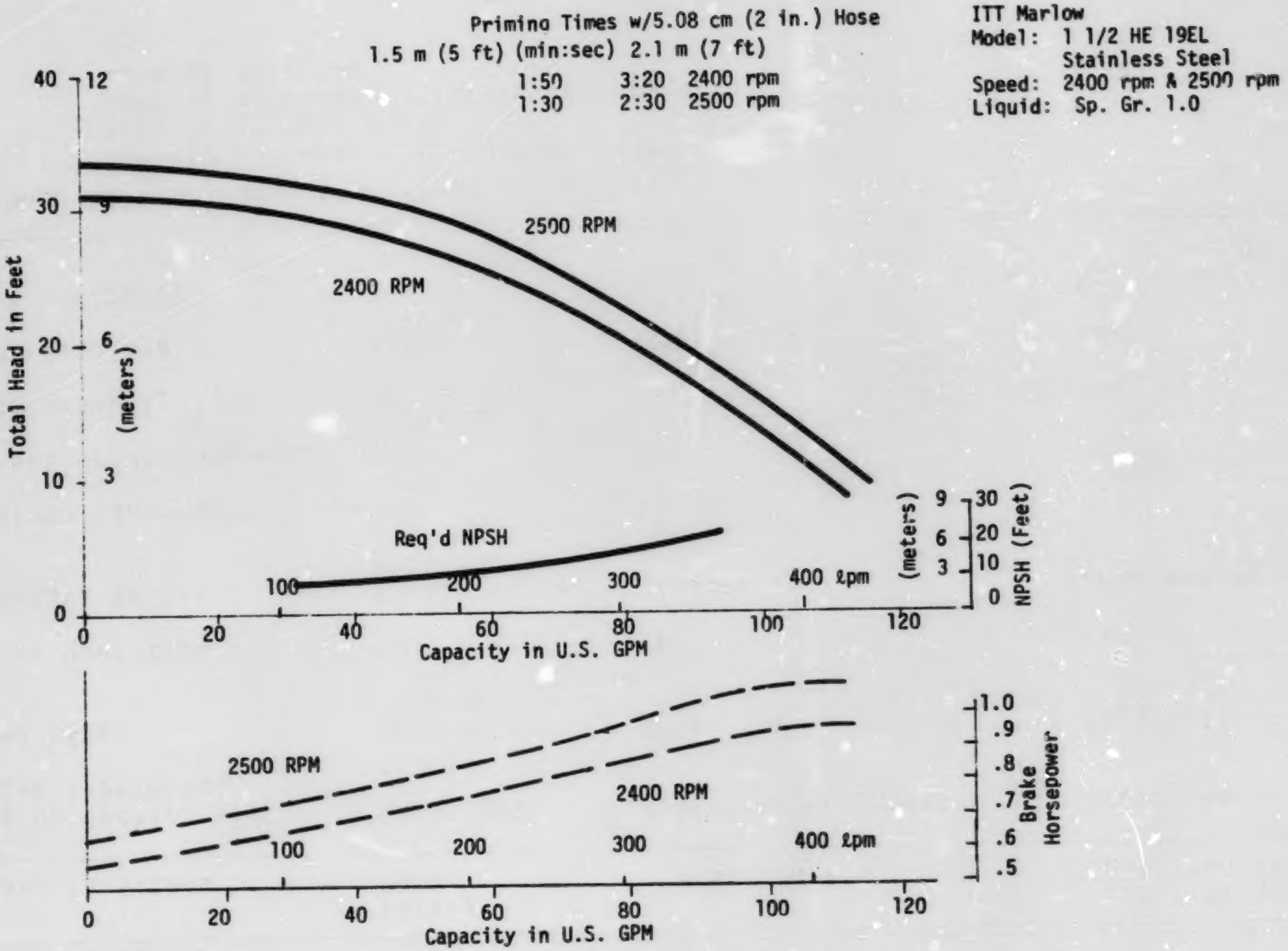


Figure 2. Pump performance curves

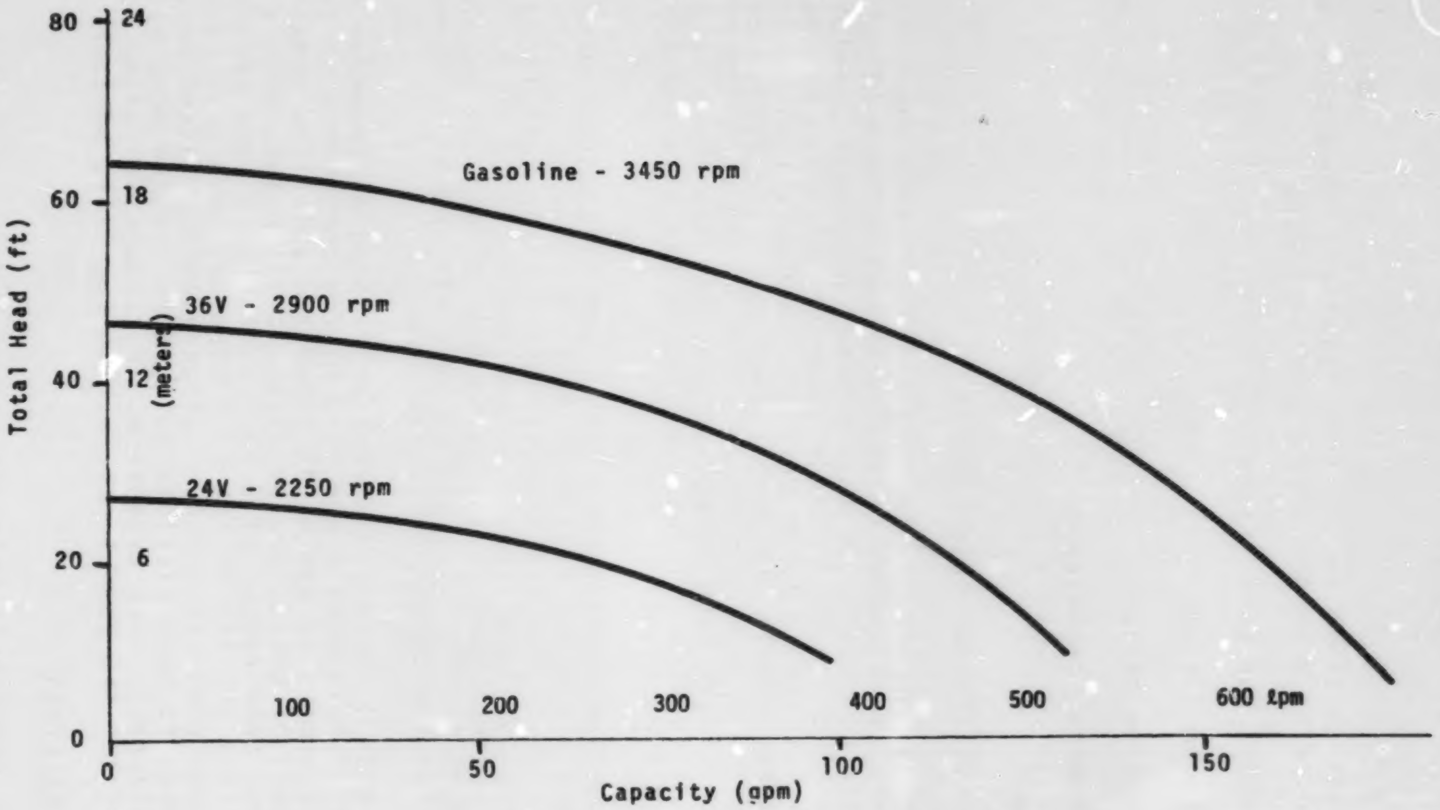


Figure 3. Effect of pump speed on capacity

FLUID HANDLING COMPONENTS

Hoses

Hose size was dictated by the pump selected. Hose type, however, was influenced by a number of factors including:

a. Weight per unit length

b. Vacuum rating

c. Bending radius

d. Chemical resistance

e. Cost

f. Durability of outer jacket

Bending radius was one of the most critical items since it dictated the minimum diameter of the hose reel. The reel is one of the larger components in the system. With most chemical service hose of 5 cm (2 in.) inside diameter (dictated by the pump), the bend radius was so large that an acceptable reel could not be accommodated within the design envelope. The system was designed to contain 30 m (100 ft) of hose in two 15 m (50 ft) lengths. No single hose selection was possible which rated "good" on all factors. It was decided to evaluate two types of hoses on the first model.

a. A Teflon suction hose with a spiralled steel wire reinforcement and a braided stainless steel outside jacket (Titeflex R276). This hose has a static-dissipating convoluted Teflon-fiberglass innercore, a vacuum rating of 71 cm Hg (28 in. Hg), and a minimum bend radius of 0.18 m (7 in.). A smaller diameter (0.04 m [1.5 in.]) Teflon hose was chosen to connect the pump discharge to the collection bag.

b. A 0.05 m (2 in.) diameter acid-chemical transfer hose (Gates 45HW). This uses a modified olefin compound with an outer reinforcement of synthetic fiber and spiralled steel wire between layers of braid, has no static dissipation, with a rated minimum bend radius of 0.12 m (5 in.). On the second model, two 15 m (50 ft) sections of chemical hose were used instead of one chemical and one Teflon/stainless steel hose. The steel hose is more flexible but can be crushed more easily and is considerably more expensive. A conductive Teflon hose was retained for the pump-to-collection bag link, however.

Valves and Fittings

All plumbing components selected are stainless steel with the exception of the inlet strainer which is nickel-plated steel. Couplings (Evertite) are provided to mate the suction hoses to tankers, strainer or to each other.

Double shut-off quick disconnects were selected for connecting the discharge hose to the system. With these, filled collection bags can be disconnected and new bags connected without spilling or leaking fluid from either the bag or the pumping system. Improvement in pump efficiency was attained by increasing the size of the pump outlet quick-connect couplings and by eliminating bends in the pump inlet piping.

The coarse inlet strainer may be attached to the hose inlet to minimize uptake of pebbles and other solids. A Y-type strainer is set just upstream of the pump in the first model to protect against the injestion of grit. In the second model a basket type strainer was used in the same location.

Hose Reel

The hose reel selected for the first model is a 0.39 m (15-1/2 in.) inside diameter double reel (Hannay Co. Model 8234-33-34) capable of holding the two 15 m (50 ft) lengths of hose. One length is attached through the rotary seal to the pump while the other length is coiled separately.

This hose reel configuration was selected because of its versatility in handling a number of situations as follows:

a. Pumping from a diked area or tanker within 15 m (50 ft) of the system (one hose only).

b. Pumping from a diked area or tanker within 30 m (100 ft) (2 coupled hoses).

c. Pumping from two diked areas or tankers or combination (2 separate hoses).

At times when only one hose is needed the other remains coiled on the reel. A bulkhead separates the two sections of the reel. A geared manual crank is provided for hose rewind.

For the second model two individual hose reels were employed, one with an axial swivel fitting as in the first model, and one with no such fitting to be used simply for storage. This arrangement facilitates the independent deployment of the hoses. Separate cranks are provided.

POWER SUPPLY AND ACCESSORIES

Batteries

Battery types considered as possible motor power supplies included silver oxide-zinc, silver oxide-cadmium, nickel-cadmium, nickel-iron and lead-acid. The basic requirements set by the motor were 38.3 amps at 25 volts DC for two hours with no downtime for charging or replacement. Factors considered in battery selection included the following:

- a. Shelf life
- b. Cost
- c. Energy density
- d. No. of cells
- e. Charging requirements
- f. No. of allowable recharge cycles

Table 3 summarizes each type in terms of the important requirements. With the exception of orientation, the lead-acid battery exhibited the best combination of characteristics.

The battery finally selected for the first model was the Globe gel/cell, Part No. GC12200, which is a modified lead-acid battery using a gelled type of electrolyte in place of water. This modification permits the battery to be sealed, eliminating the orientation difficulty. Technically, silver-zinc and silver-cadmium were also acceptable and in some terms slightly superior. Cost, however, was significantly greater both for the cells and the charging system. For the purpose of the first unit, twelve of the gel/cells were considered adequate.

Included in the battery circuit is an explosion-proof motor starter (Control Products P/C 25203) which incorporates a run-charge selector, start switch, and a voltage level monitor (Calex Voltsensor Model 325) to protect the batteries from deep discharge. The latter component monitors the battery voltage continuously. An output signal from the monitor is used to initiate visible and/or audible alarms.

A separately packaged battery charger is used to maintain the charge level of the battery pack during storage. A constant voltage power supply (Power Mate Corporation Model UNI-30F) is used in series with a current limiting rheostat in order to maintain a float potential of 27.3 volts. It remains connected to the batteries constantly during standby times.

A schematic battery charger circuit is given in Figure 4. Characteristics of the gelled lead-acid cell are given in Table 4.

Table 3. BATTERY SYSTEM CHARACTERISTICS*

Battery	No. of Cells Required	Energy Density (watt-hrs/ cc[cu in.])	Specific Energy (watt-hrs/ kg [lb])	Discharge Current	Shelf Life	Cost	Orientation	Charging
Lead-acid	B	B	B	A	A	A	U	A
Silver-zinc	A	A	A	B	B	U	A	U
Silver-cadmium	A	B	B	B	B	U	A	U
Nickel-cadmium vented pocket plate	U	B	U	A	A	B	A	U
Nickel-iron	B	B	B	U	B	B	U	B
Nickel-cadmium sintered plate	B	B	U	A	A	U	A	U
Lead-acid-gelled electrolyte	B	B	B	A	A	B	A	A

* A - Superior
B - Acceptable
U - Unacceptable

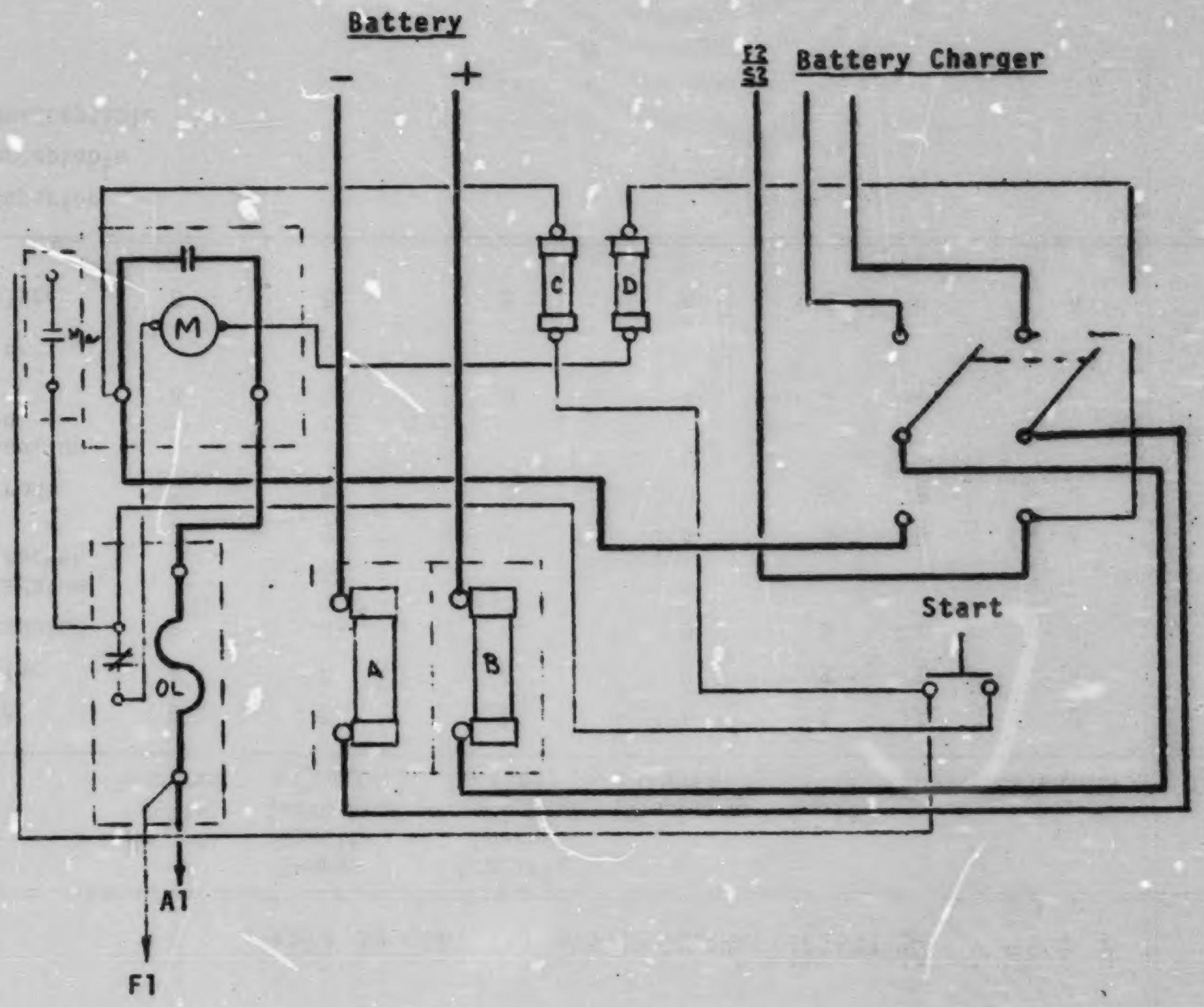

Battery
−
+
F2
S2
Battery Charger
C
D
M
A
B
OL
Start
A1
F1

Figure 4: Motor starter wiring diagram

Table 4. GELLED LEAD-ACID CELL CHARACTERISTICS

1.	Nominal voltage	12 volts (6 cells in series)
2.	Nominal capacity at:	
	1.0 ampere (20 hr rate) to 10.5 volts	20 A.H.
	1.9 amperes (10 hr rate) to 10.26 volts	19 A.H.
	3.5 amperes (5 hr rate) to 10.14 volts	17.5 A.H.
	11.0 amperes (1 hr rate) to 9.6 volts)	11 A.H.
3.	Weight	7.6 kg (16.75 lbs)
4.	Energy density (20 hr rate)	0.43 watt-hours/cc (1.1 watt-hours/cubic inch)
5.	Specific energy (20 hr rate)	6.5 watt-hours/kg (14.3 watt-hours/pound)
6.	Internal resistance of charged battery	Approximately 18 milliohms
7.	Maximum discharge current with standard terminals	100 amperes
8.	Operating temperature range:	
	Discharge	-60°C to +60°C (-76°F to +140°F)
	Charge	-20°C to +50°C (-4°F to +122°F)
9.	Charge retention (shelf life) at 20°C (68°F)	
	1 month	97%
	2 months	91%
	6 months	82%
10.	Sealed construction - can be operated, charged or stored in ANY position without leakage of any corrosive liquid or gas. Battery protected against internal pressure build-up by self-sealing vents which pass only dry gas.	---
11.	Terminal - 0.6 cm (1/4 in.) quick connect. Will accept AMP, Inc. Faston "250" series receptacles or equivalent.	---
12.	Case material - high impact polystyrene, light gray in color.	---

LIQUID FUEL

In order to improve pump efficiency for the second model, several configurations using liquid fuel were considered. One of these involved an electric pump motor driven by a diesel-powered generator. Another configuration considered was a direct drive pump with a liquid fuel-powered engine.

The power supply finally selected for the second model was an explosion-resistant 3-HP single cylinder gasoline engine, close-coupled to the same type of pump used in the first model. This engine provided a pump speed of 3450 rpm with a corresponding increase in pump capacity. Comparative pump performance curves are shown in Figure 3. The second model pump and engine unit is also more compact and lighter weight than the first model. Further decreases in size and weight are realized through the elimination of the batteries, rack, support structure, and motor starter cabinet.

SECTION 6

COMPONENT ASSEMBLY

FIRST MODEL

A detailed study was undertaken to determine the most feasible component arrangement. A component layout plan for the first system is shown in Figure 5. Due to size limits imposed on the system, component assembly was a case of finding a way to fit all items on a 1.2 m x 1.2 m (4 ft x 4 ft) base.

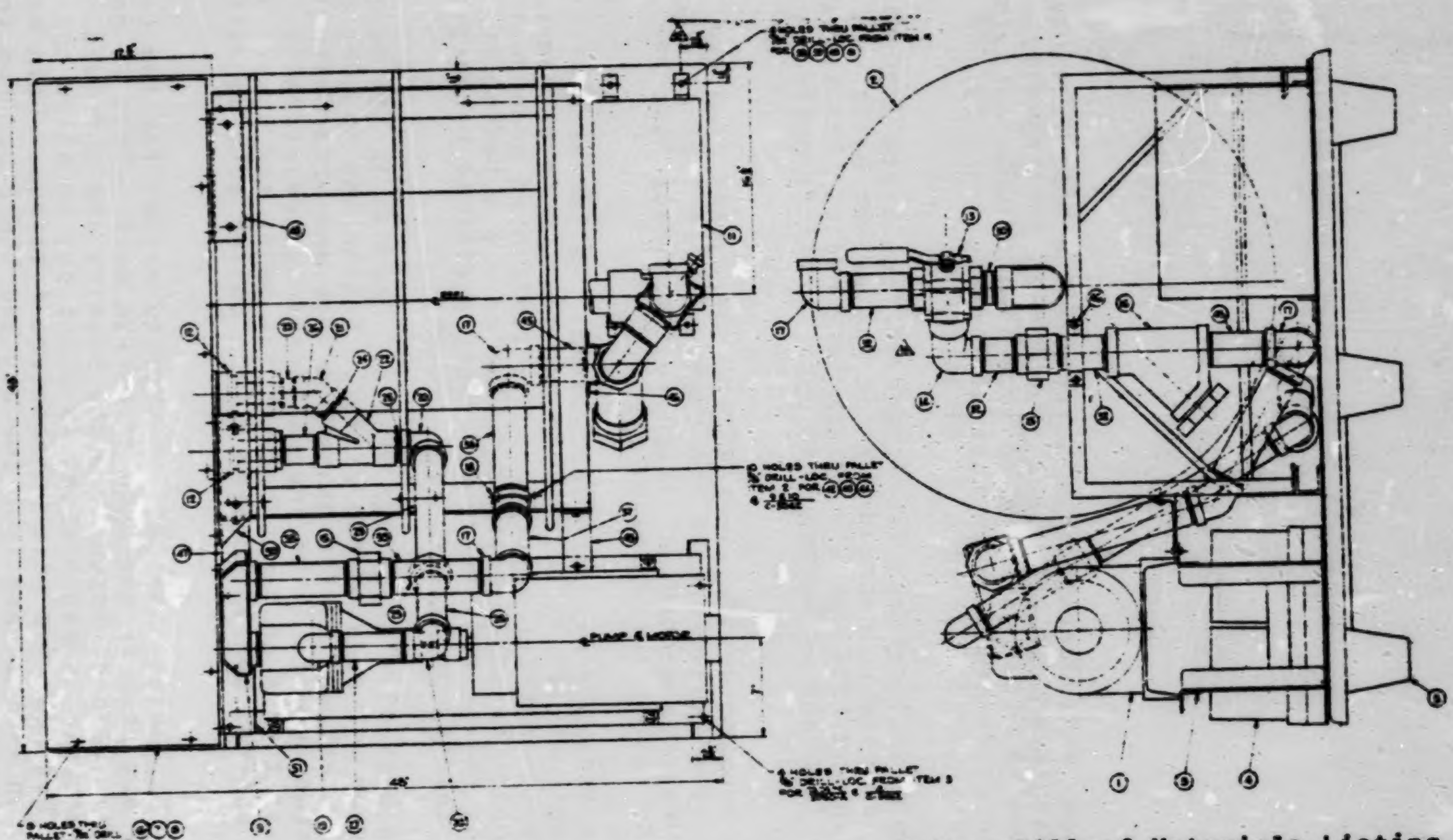
Three items were designed and fabricated to facilitate assembly. A ribbed and laminate-reinforced plastic pallet was built to serve as a mounting base for all system components. The system may thus be lifted and/or transported by a fork-lift having 1.2 m (48 in.) arms.

A special bag housing was fabricated from corrugated aluminum and stainless steel angle braces. A drop-away front panel contains a quick-release mechanical latch to facilitate fast deployment of the bag at the scene of a spill.

A battery rack assembly was also fabricated. Batteries are arranged in two rows of six cells each and mounted in a framed tray. The tray, supported on casters, is positioned underneath the pump and motor assembly channel. Handles are attached to one side of the roller tray to provide easy access to battery terminals for testing or battery replacement.

Figure 6 is an overall view of the system. The bag in its housing is mounted on one edge of the pallet. Behind the housing on one side is the reel and on the other the pump and motor with the batteries located beneath. The low voltage detector/alarm is mounted adjacent to the coupling between the motor and pump. The motor starter control box is located at the pallet edge opposite the bag housing.

The system, as assembled, is ready to operate except for the connection of the bag hose to the pump discharge port. This is done after the bag has been deployed from the housing and unfolded. At the lower rear of the bag housing is a cut out to allow connection of the bag hose via quick disconnect fittings. Both ends of the connection -- the hose from the bag and the pipe from the pump discharge port -- are closed automatically when unplugged.


PUMP & MOTOR
48"

Note: Bill of Materials Listing
in Appendix C

Figure 5. Layout plant for first model

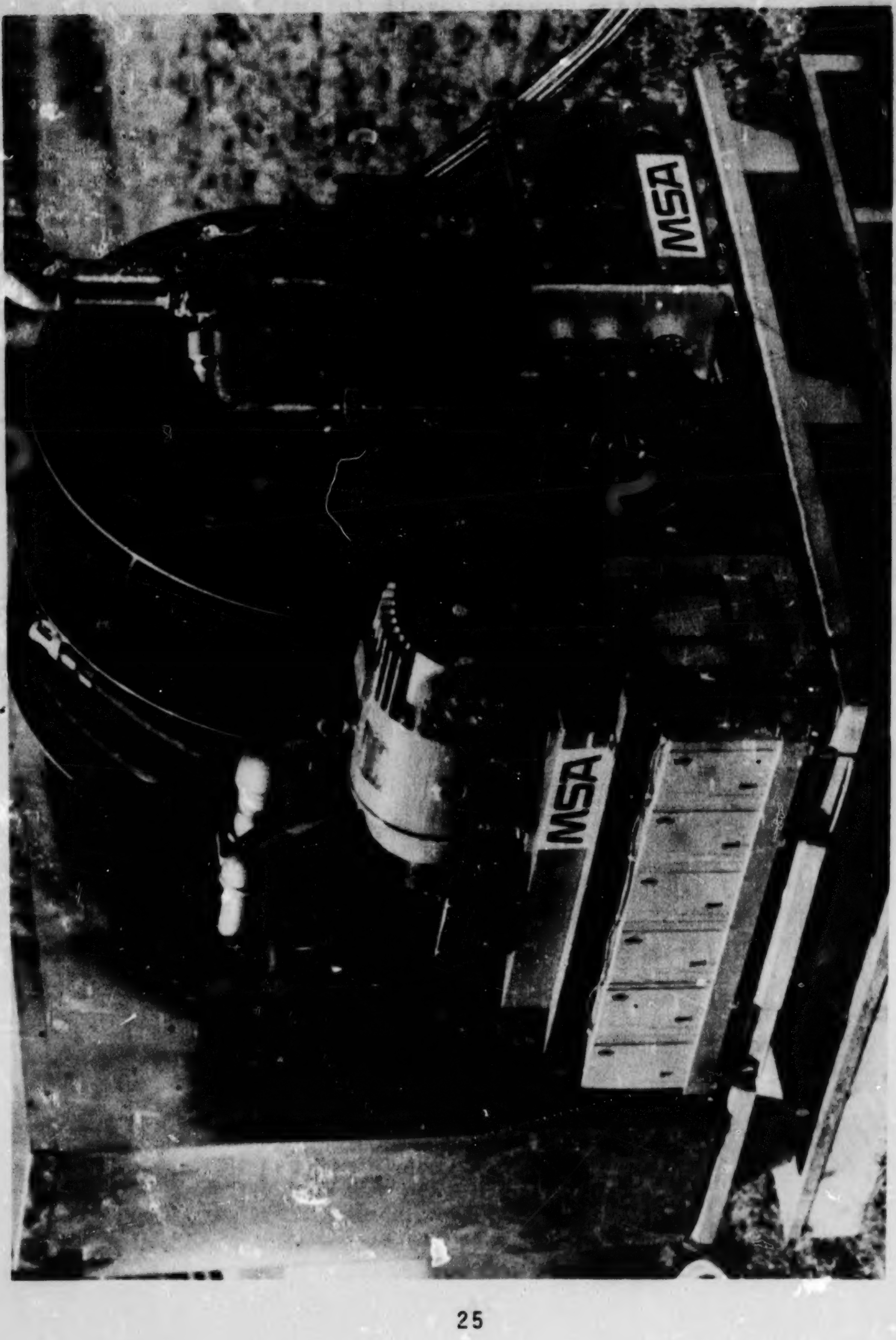


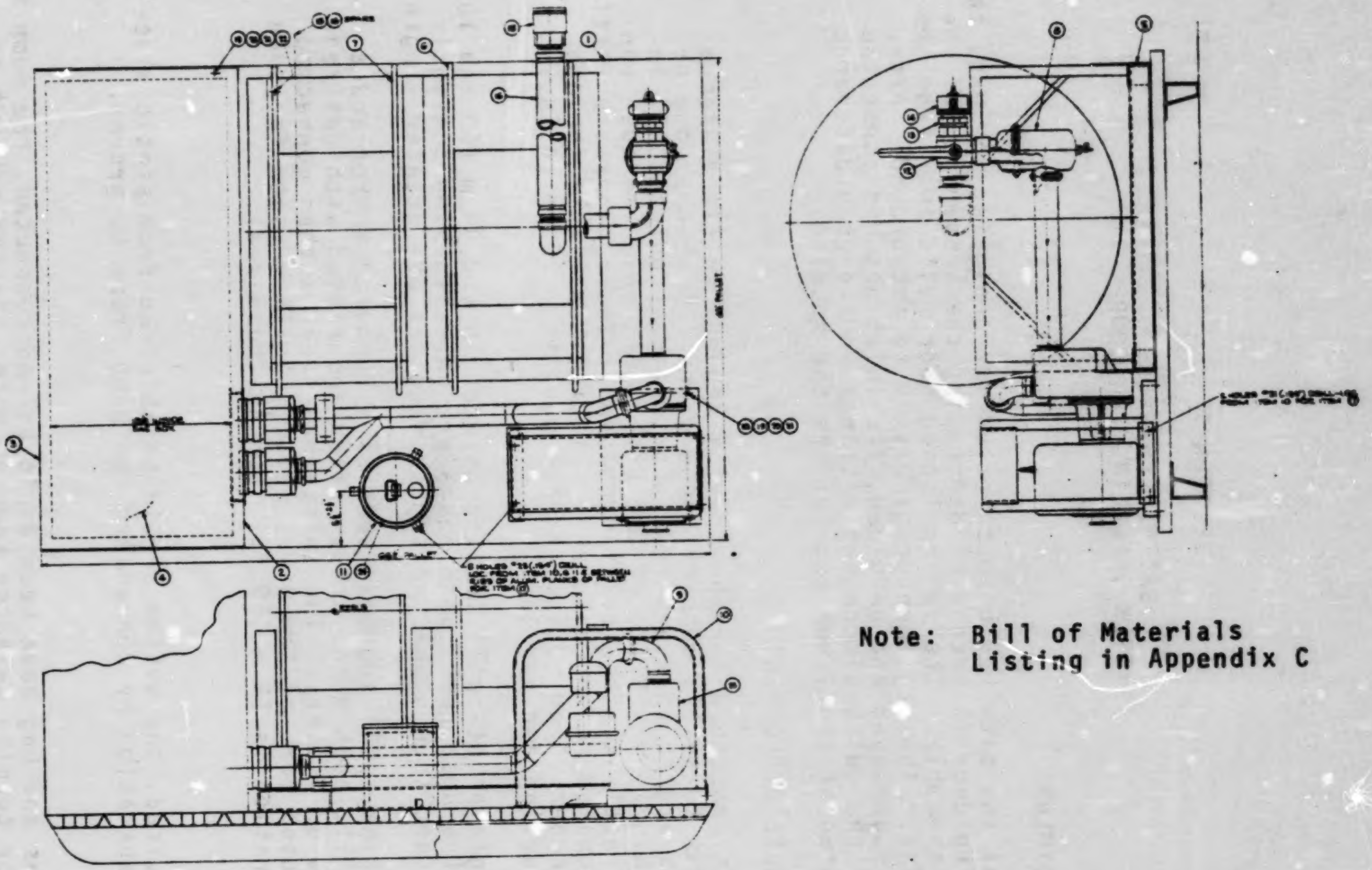
Figure 6. Overall view of first model

In this way disconnection cannot result in spillage from either the bag or the pumping unit. A second quick disconnect is provided to allow two bags to be filled from the same pump discharge. Since both quick disconnects are manifolded together they may be used to switch in a second bag after the first is full without shutting down the pump and without spillage.

A three-way ball valve located adjacent to the hose reel allows two spill pickups to be connected to the pump suction port. Although they cannot operate simultaneously, there are potential instances where alternation between two pickups may be desirable, such as the draining of a damaged vehicle and the collection of material already spilled from the vehicle.

SECOND MODEL

The component layout plan for the second model is shown in Figure 7. The general plan of the first model was retained with respect to positioning of collection bag housing, hoses and pump. The pallet size was increased to 1.2 m x 1.8 m (4 ft x 5.5 ft) to accommodate the larger bag housing and piping. An aluminum pallet was used instead of a plastic one to achieve greater rigity and stability. Remaining pallet space was allocated to a 3.8 ℓ (1 gal) explosion-proof gasoline container and a parts and tool box. Plumbing was revised to achieve lower pressure drop. A three-way ball valve was installed which permits pumping from either or both of the inlet hoses simultaneously.



Note: Bill of Materials
Listing in Appendix C

Figure 7. Layout plan for second model

SECTION 7

BATTERY POWERED SYSTEM OPERATING PROCEDURE

BAG DEPLOYMENT

As soon as the site has been selected for deploying the bag, the bag housing door is opened by depressing the keeper bar of the latching assembly. The spring loaded door falls away from the bag housing. The bag then drops easily to the ground. After the bag is deployed and unfolded, the inlet hose is connected to one of the quick-disconnect fittings on the pump discharge line located at the lower rear of the bag housing.

SUCTION HOSE DEPLOYMENT

Deployment procedure for the hose(s) depends on (1) distance from system to spill, sump or tanker, and (2) whether one or two points are to be evacuated. For a single point spill located within 15 m (50 ft) of the hose reel, only the hose connected directly to the reel is deployed. The appropriate fitting is then mounted on the hose end. Fittings available include filter chamber, 5 cm (2 in.) tanker coupling, 10 cm (4 in.) tanker coupling and nozzle.

For a single point-spill located between 15 and 30 m (50 and 100 ft) from the hose reel, both hoses are unreeled simultaneously. The hoses are then connected together to achieve greater length.

For two point-spill sources, such as a ruptured tanker and a ground spill, both hoses are unreeled and fitted with desired connectors or filters. The unattached hose is then connected to the unused port of the 3-way valve. Maximum range for such a configuration is 15 m (50 ft) from the hose reel.

GROUNDING

Where required, the system should be shielded from static electricity generation by connecting the pump frame to ground.

PUMPING

After hoses and bag have been deployed and connected, the pump is actuated by turning selector knob on motor starter cabinet to

"RUN" and depressing the "ON" push button momentarily. The three-way ball valve handle must be in the its down position in order to pump via the hose attached to the hose reel and rotary seal. In its up position pumping action is via the port located above the valve. With the batteries fully charged and no restrictions in the pump lines, the system will pump up to 2-1/2 hours.

An operating manual included as an Appendix has been prepared which describes in detail the procedures for recharging the batteries and servicing the individual systems components. A complete parts list is also included.

SECTION 8

GASOLINE POWERED SYSTEM OPERATING PROCEDURE

The procedure is similar to that detailed previously for the battery powered system. Only modifications in procedure are described below.

BAG DEPLOYMENT

The door of the bag housing is opened by pulling the tabs on the spring-loaded bolts inward, toward each other.

PUMPING

After hoses and bag have been deployed and connected, the pump is started by pulling out the choke plunger and then pulling vigorously on the rope coiled atop the engine housing. When the engine starts, choke should be readjusted for optimum pump speed. The three-way ball valve handle must be in its up position, i.e., pointing upward, in order to pump via the hose attached to the hose reel and rotary seal. In its down position pumping action is via the second valve port. When the valve handle is horizontal and pointing left (toward the engine) then both ports are open to the inlet of the pump. With a full tank of gasoline, and no restrictions in the pump lines, the system will pump for ∼two hours. Longer pumping time may be obtained by transferring fuel from the explosion-proof container mounted on the pallet behind the bag housing.

An operating manual has been prepared as an Appendix which describes these procedures in more detail. Brochures on system components and a complete parts list are included.

SECTION 9

SYSTEM TESTING

The following tests were conducted with either one or both models of the collection system.

1. A material strength test on the first system was performed by filling the bags with 23,500 ℓ (6200 gal) of water. Intentions were to continue filling to the 26,500 ℓ (7000 gal) rated bag capacity however a pinched connecting tube prevented transfer of additional water from the header bag to one of the feeder bags. Water was pumped to the system via a fire hose through an in-line integrating flow meter at a rate of 197 ℓ/min (52 gpm).

2. A patch kit test was performed on the filled bags of the first model and on the semi-filled bags of the second model. Several holes had become noticeable in the bags by emitting drops or thin sprays of water. Attempts to repair these holes showed that patches would not adhere to a wet surface, however, small plugs could be inserted which effectively stopped the leaks. Patches may be applied to clean dry surfaces of the bag, pretreated with methyl ethyl ketone.

3. The effect of pump speed (rpm) on flowrate (gpm) was measured. In order to increase the rpm of the pump in the first model, the batteries were rewired to provide 36 volts (37.5 volts open circuit) instead of 24 volts. This change increased the pump motor speed from 2263 (under load) to 2882 (also under load). Three trial times were obtained by circulating water from one 208 ℓ (55 gal) drum to another via a 15 m (50 ft) length of 5 cm (2 in.) diameter chemical transfer hose and a 3 m (10 ft) of 3.8 cm (1-1/2 in.) corrugated Teflon hose. Two tests at 24 volts were also carried out. Results are shown in Table 5. Hence, a 27% increase in pump speed resulted in a 25% increase in water flowrate. Operation of the unit at the higher voltage presents no apparent problems since the pump is rated up to 3600 rpm. The current drain is proportionately lower at the higher voltage hence battery life should remain near 2.5 hours of continuous operation before recharging.

Table 5. EFFECT OF VOLTAGE AND SPEED ON PUMP FLOWRATE

Voltage (volts)	Avg. Speed (rpm)	Avg. Flowrate (ℓpm)	(gpm)	% Change in Flowrate
24	2263	160.9	42.5	--
36	2882	201.4	53.2	25.2

Similar determinations were made with the gasoline engine powered second model which employs a similar pump. Results were as follows:

Avg. Speed (rpm)	Avg. Flowrate (ℓpm)	(gpm)
3450	301.3	79.6

4. Both models were operated with materials of widely varying viscosities. Trial times were obtained by circulating the material between 208 ℓ (55 gal) drums. Viscosities were determined by Ostwald viscometer on aliquots taken from each material tested. In the case of a sodium silicate/water solution, continued pumping resulted in a decreasing flowrate due to the separation of the two phases. Results are given in Table 6. These results were used to obtain the regression curves shown in Figure 8.

5. Both models were operated with materials of widely varying vapor pressures. Trial times were obtained by priming the hoses and pump, then circulating the material between 208 ℓ (55 gal) drums. Vapor pressure values were taken from the literature. Results are given in Table 7. No attempt was made to determine synergistic effects of various material properties on these results. Regression lines based on these date are presented in Figure 9.

Table 6. EFFECT OF MATERIAL VISCOSITY ON PUMP FLOWRATE

	Viscosity (cp)	Viscosity (cs)	Avg. Pump Rate (ℓpm)	Avg. Pump Rate (gpm)
First Model:				
Water	1.0	1.0	159.0	42.0
NaSiO$_3$/water	1.6	1.5	159.0	42.0
"	2.3	2.0	155.2	41.0
"	25.0	19.4	~113.6	~30.0
Polyvinyl propylene	19.4	19.6	124.5	32.9
Second Model:				
Water	1.0	1.0	301.3	79.6
Oil/kerosene	20.3	23.9	238.5	63.0
"	31.8	37.9	218.8	57.8
"	68.7	82.8	184.7	48.8
SAE 50 oil	348.5	435.0	0	0

Table 7. EFFECT OF VAPOR PRESSURE ON PUMP FLOWRATE

	CH$_2$Cl$_2$	Acetone	Water
Boiling Point (°C)	40.1	56.5	100.0
Boiling Point (°F)	104.2	135.5	212.0
Vapor Pressure at 20°C (mm Hg)	265.0	175.0	17.6
Pump Rate			
1st Model (ℓpm)	142.3	175.2	168.1
1st Model (gpm)	37.6	46.3	44.4
2nd Model (ℓpm)	187.0	290.7	301.3
2nd Model (gpm)	49.4	76.8	79.6

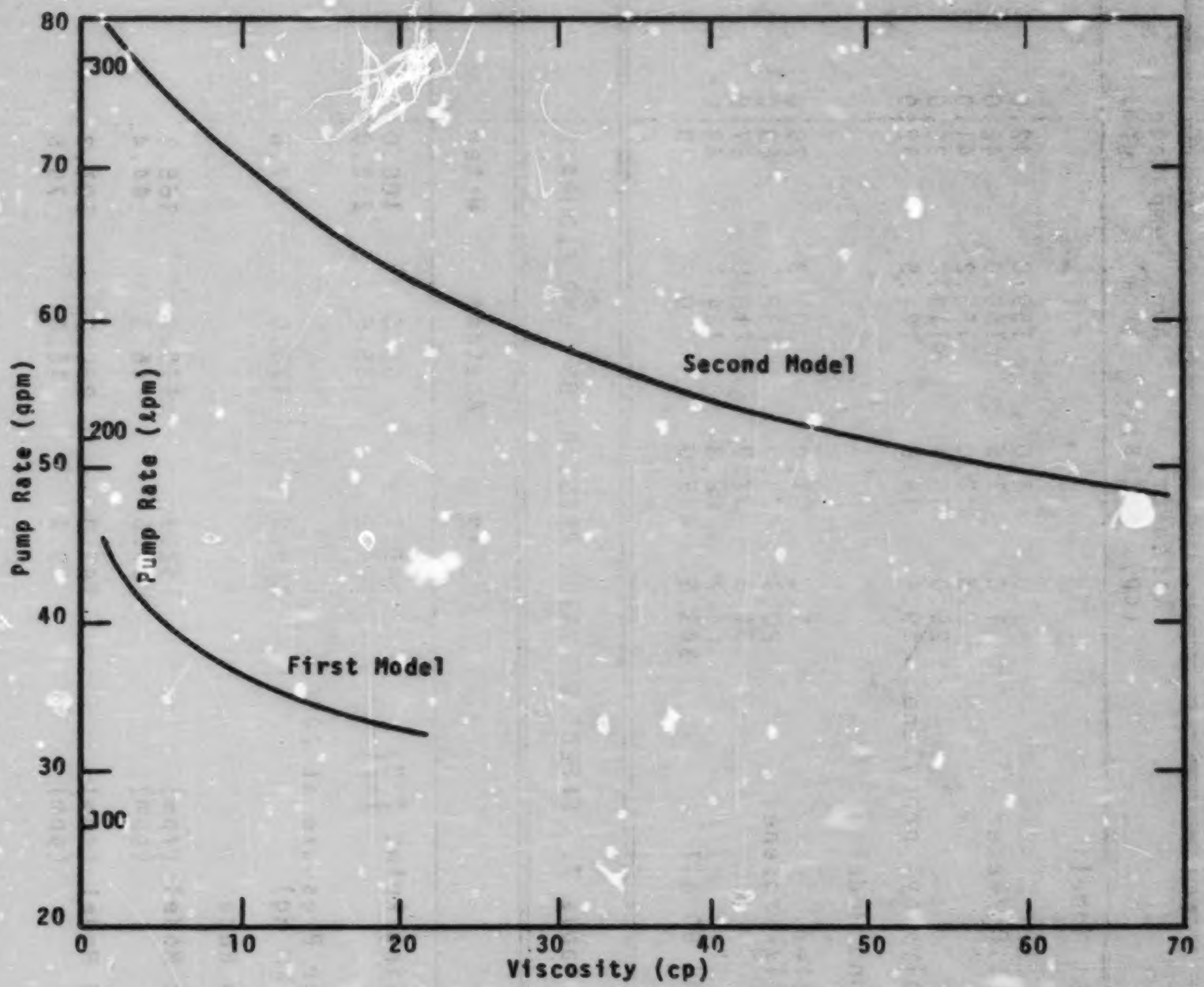


Figure 8. Pump rate as a function of viscosity

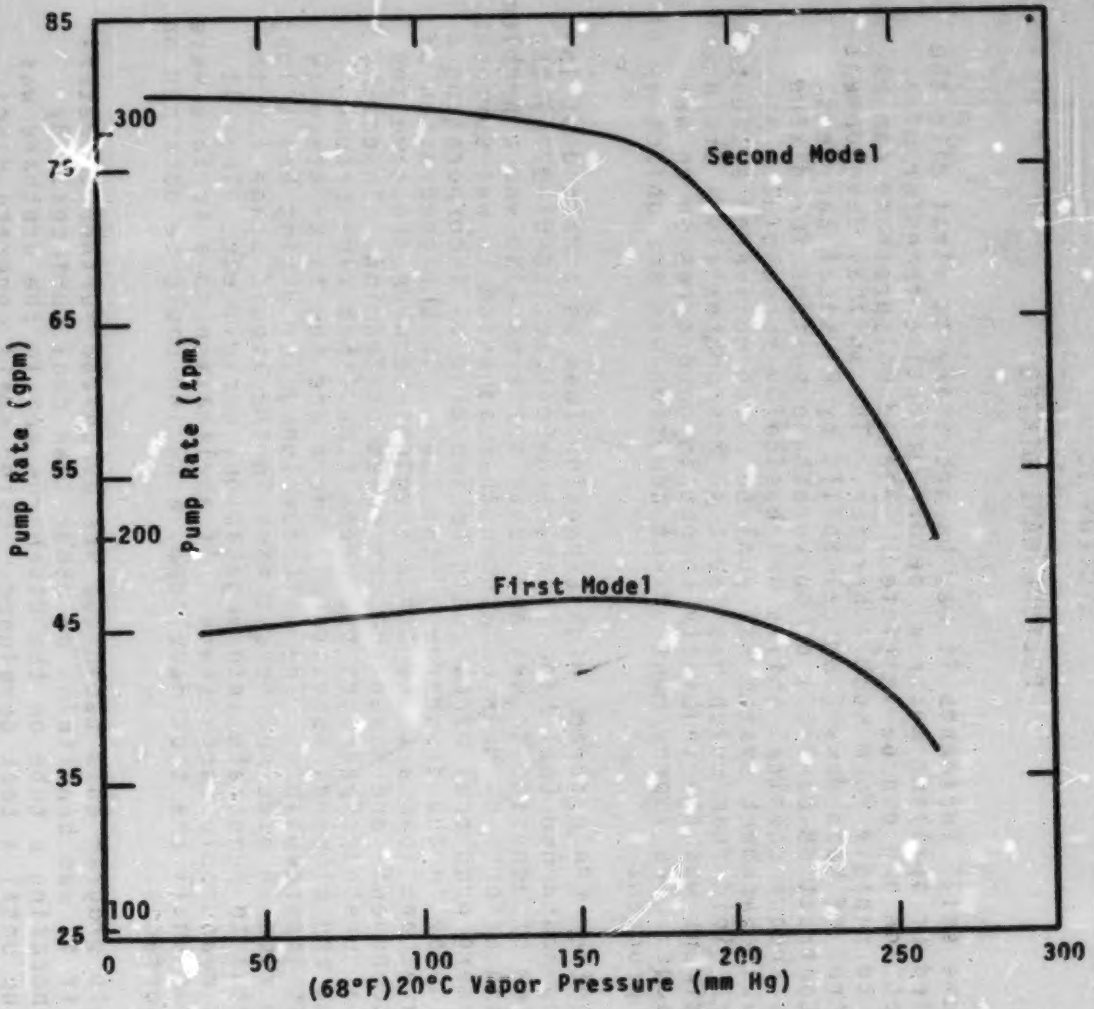


Figure 9. Pump rate as a function of vapor pressure

SECTION 10

POLYURETHANE DIKING

In some spill incidents it may be necessary to first dike the spilled or spilling material before effective transfer of a collection bag can be initiated. Foamed polyurethane can be used to rapidly form such a barrier. The initial development (Control of Hazardous Chemical Spills by Physical Barriers, EPA Contract 68-01-0100) of polyurethane systems for diking of hazardous chemical spills was basically successful. A portable backpack system was evolved which delivered a lightweight rigid foam which was inert to most materials. Its one impediment was the inability to obtain good adhesion on wet surfaces. The improvement of wet adhesion was one objective of this program.

In another EPA program (High Expansion Foam as a Method of Inerting Abandoned Coal Mine Areas, EPA Contract 68-01-0716) the problem of adhesion to wet and dusty surfaces also was a problem. Ongoing efforts by MSAR had shown that adhesion to wet surfaces in underground coal mines could be improved by incorporating a time delay in the discharge of the foam. In the generation of polyurethane foam a tacky stage develops between the time the two components are mixed and the onset of foaming. In commercial urethane packages the cream time, that time between mixing and blowing, is extremely short and the tacky stage is almost imperceptible. The unit developed for diking has a long cream time to give sufficient time in the liquid stage for the material to penetrate into vegetation, gravel, etc. Thus it has a measurable tacky stage. If application to a surface were held up until the tack developed, adhesion could be obtained on wet surfaces.

In this program this technique was evaluated further to determine if it was beneficial on other than coal surfaces. By incorporating a tube on the discharge nozzle the urethane was held up until a tack developed. Using small concrete discs adhesion was measured qualitatively. Adhesion could be developed on wet concrete surfaces but the degree was a function of wetness. On damp surfaces adhesion was almost as good as on dry surfaces. With water puddled on the concrete adhesion was still poor even using the time delay. Where water could not collect, such as in vegetation, bare ground, and so forth, the delay technique was effective.

Table 8. CHEMICAL COMPOSITION OF DIKE-PAK 150

Material	Tradename	% by Wt.
Isocyanate	Mondier MR 133	30.30
Polyol	Multranol 4034	16.20
Polyol	Voranol RA800	6.40
Catalyst	Polycat 8	0.47
Catalyst	PbN	0.06
Surfactant	L5340	1.37
Freon	R11B	45.20

Table 9. POLYURETHANE SYSTEM

Description	Dike-Pak 150
Vol. of Foam Delivered	0.6-0.7 m^3 (22-25 cu ft)
Delivery Rate (avg.)	0.14 m^3/min (5 cfm)
Weight (gross)	15.9 kg (3.5 lbs)
Size	40x40x20 cm (16x16x8 in.)
Storage Time	6 mos to 3 yrs
Storage Temperature (range)	10 to 65°C (50 to 150°F)
Useful Temperature (range) (substrate)	-10 to +50°C (15 to 120°F)

SECTION 11

DEMONSTRATIONS

Upon completion of component assembly, the first model was field tested to verify its performance characteristics. The site selected for testing was a pond which serves as a chemical disposal facility located on the MSA Evans City plant property. The pond contains about 200,000 ℓ (50,000 gal) of water with a pH of about 9. It was planned to set the unit up at the edge of the pond and go through all of the procedures involved in normal operations to demonstrate operability and to note any problem areas not anticipated previously.

The collection system was moved by means of fork lift vehicle to a point adjacent to the pond. In the initial test the bag and housing were removed from the system and not used. The 15 m (50 ft) length of stainless steel/Teflon hose was unreeled and its nozzle dropped into the pond. The pump was started and water was pumped from the pond, through the system, and back to the pond. In this series of tests the pump was located about 2.5 m (7.5 ft) higher in elevation than the surface of the pond water. Pumping time required for initial flow from the system exit port was about six mintues. Flow rate was 163 ℓ/min (43 gpm).

At the conclusion of the initial test the batteries were recharged at 27.3 volts. Charge current was maintained at 1.0 amp. The bag and housing were then reinstalled on the pallet for a field demonstration of the system. The bag was removed from its housing, deployed and the pump started. Within six minutes the header segment of the bag began to fill. Pumping was stopped after 35 minutes with approximately 5,700 ℓ (1500 gal) in the bag segments. About 40% of this total was in the header segment. The bag was then emptied to the pond, cleaned, dried, evacuated and refolded. Batteries were again recharged.

The final demonstration of the series was similar to the previous one but involved two hours of pumping time. No measurement was made of the volume pumped, but the bag system was about three quarters full. Some water inadvertantly leaked from the header segment due to a loose fitting screw clamp on the drain port. This leakage went unnoticed for at least 30 minutes. The demonstration was witnessed by EPA personnel and recorded on film.

In a full-scale demonstration the second model collection system was mounted on the bed of a 3/4 ton pickup truck. A 26,500 ℓ (7000 gal) capacity tank of the type used in road tanker trucks was filled with water to which an innocuous red dye had been added. In the demonstration run, a tanker leak was simulated by actuating a motor operated ball valve located on the underside of the tanker. Urethane foam dikes were then established nearby to collect the spilled material and to divert portions of the spill into the primary dike. The pickup truck bearing the collection system was then driven to a point adjacent to the diked area. Hoses were deployed to the dike and to the tanker. The bag was then removed from its housing and unfolded on the ground behind the truck. The engine was then started and the spilled material pumped from the dike area trench to the bags via one of the 15 m (50 ft) hoses. The second 15 m (50 ft) hose was connected to a fitting located at one end of the tanker. When the tanker leak subsided, the 3-way valve in the system was rotated to admit liquid from the tanker to the pump which in turn continued to transfer it into the bags. The hoses were then reconnected and liquid was pumped from the bags back into the tanker. Events of the demonstration were recorded on film and witnessed by EPA personnel. An overview of the demonstration area is presented in Figure 10.

Figure 10. An overview of demonstration area

APPENDICES A, B AND C

APPENDIX A. OPERATING MANUAL FOR BATTERY-POWERED MODEL

Introduction

The MSA Emergency Collection System for Hazardous Spills is a portable device to be used in transferring contained spilled fluids into a holding bag that is part of the system.

The purpose of this manual is (1) to provide detailed instructions for operating the battery-powered emergency collection system for spilled hazardous materials and (2) to present information required for the proper servicing and maintenance of the equipment. A parts list is included.

General Description

The purpose of the Emergency Collection System is to pump spilled hazardous fluids into a connected group of large bags for temporary storage. The system consists, essentially, of a battery-powered pumping unit and 30 m (100 ft) of suction hose in addition to the folded collection bags and their housing. It is mounted on a 1.22 m x 1.22 m (4 ft x 4 ft) reinforced plastic pallet. The bags can contained up to 26,500 ℓ (7000 gal.) of spilled fluid. The batteries provide 2 to 2 1/2 hours of pumping time without recharging which in most cases should be sufficient time to fill the bags. Additional pumping time may be obtained by substituting a battery eliminator. A change in battery interconnection provides accelerated pumping rates.

A photograph and a layout diagram of the system are presented in Figures A-1 and A-2.

System Operation

Placing the System at the Spill Site--

Upon arrival at the site of the spill the most feasible location should be selected for placement of the system and deployment of the bag assembly.

Elevation relative to spill--The efficiency of the pump is determined primarily by the vertical distance between the mouth of the suction hose and the pump inlet port (head). The system

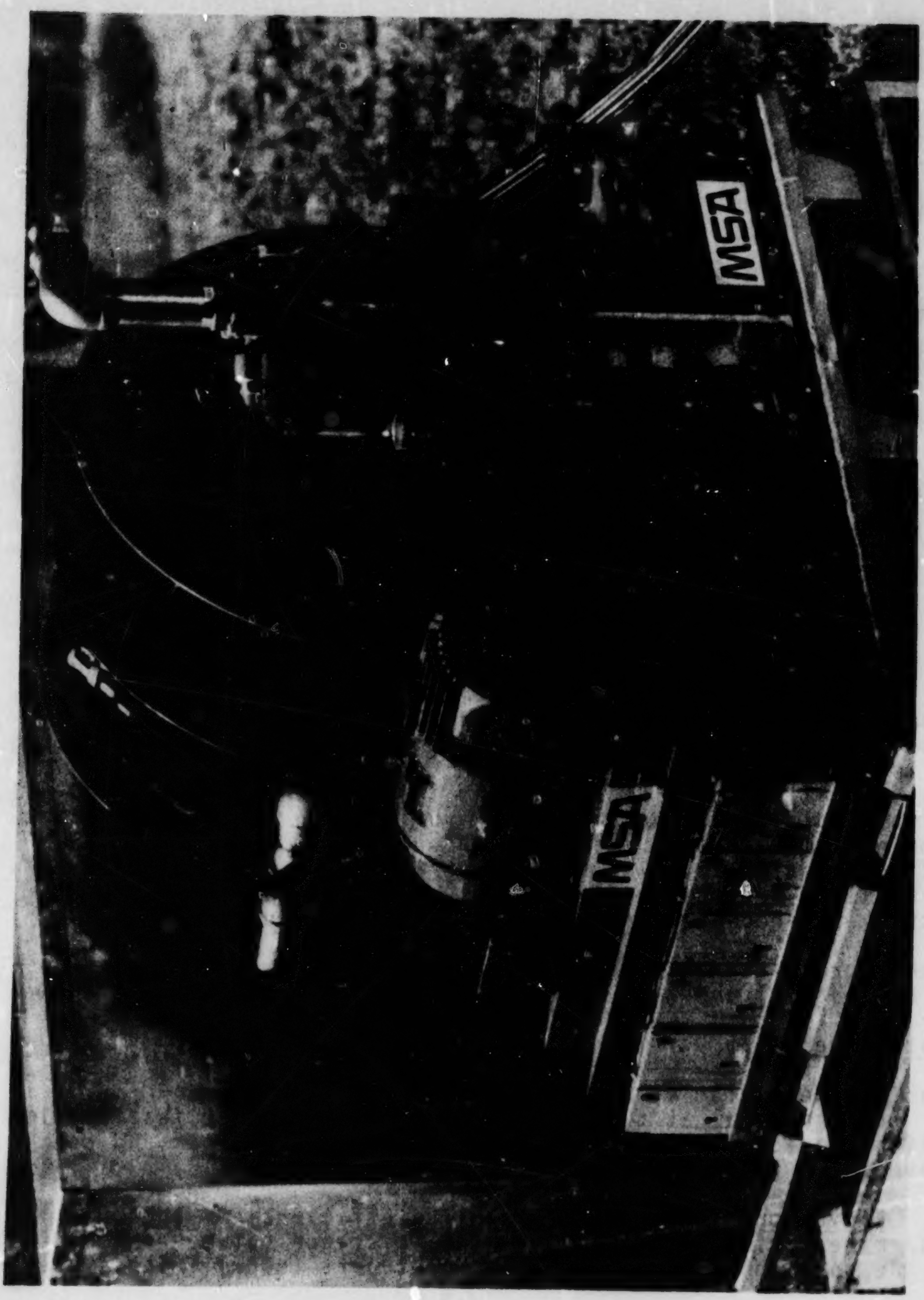
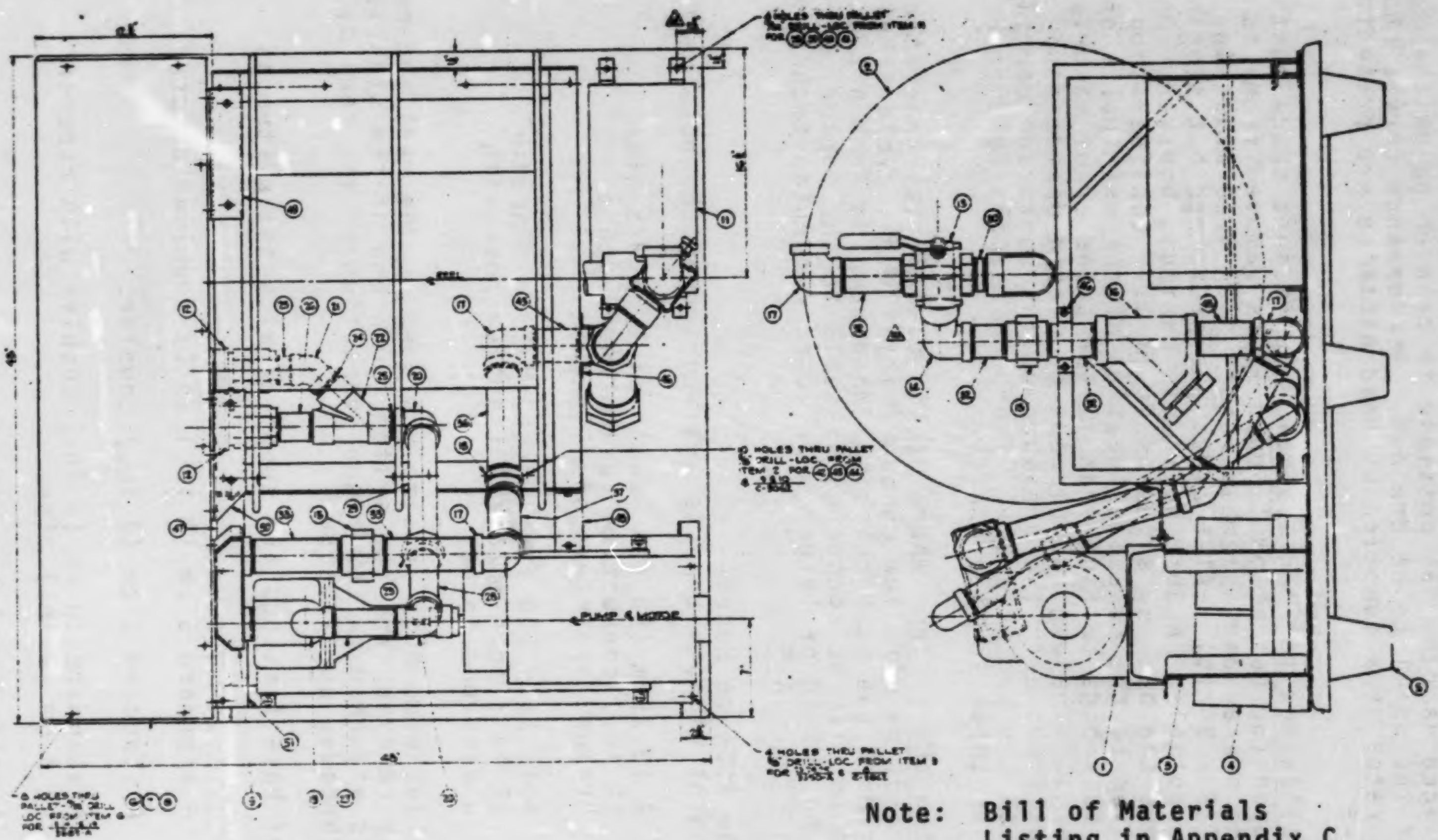


Figure A-1. Photograph of battery-powered model


PUMP & MOTOR
45"
4 HOLES THRU PALLET
10 HOLES THRU PALLET
4 HOLES THRU PALLET
6 HOLES THRU PALLET

Note: Bill of Materials
Listing in Appendix C

Figure A-2. Layout diagram of battery powered model should be placed as close as possible to or even below the elevation of the spill to be drained. Performance curves showing pumping rates as a function of head distance are presented in Figure A-3.

Space allowance for bag assembly--Sufficient space must be allowed to open the bag assembly once it is removed from its housing. The opened bag assembly requires an area measuring 8 m by 6 m (25 x 20 ft). Flat areas are preferred but sloping areas are acceptable. A 30° incline is maximum, however. On steeper slopes the bag may slide as it fills. Consideration should be given to the relative location of the exit ports on each of the four bags to facilitate later transfer of material out of the bags. The bags should not be placed upside down since this will put both the pressure relief vents and carrying straps beneath the bag assembly. The bag assembly folding arrangement is shown in Figure A-4.

Grounding the system--Where static electricity generation may be a hazard, as with low conductivity fluids, cable should be used to ground the pump chassis. When pumping from a tanker, the pump should also be connected by cable to the tanker. Wire size should be AWG 10 or larger. Selected grounding techniques are shown in Figure A-5.

Deploying the Suction Hoses--

Two lengths of suction hose are mounted on the hose reel:

1. A 15.25 m (50 ft) length of 5 cm diameter (2 in.) conductive Teflon hose with a braided stainless steel jacket.

2. A 15.25 m (50 ft) length of 5 cm diameter (2 in.) acid-chemical transfer hose with a neoprene jacket.

The neoprene jacketed hose is simply stored on the reel and may be completely removed from the system. One end of the stainless braid hose is attached to the riser connection of the reel by means of a threaded end fitting.

Five types of hose fittings are supplied with the system as follows:

1. A standard 5 cm (2 in.) quick coupling adapter.

2. A standard 5 cm (2 in.) coupler.

3. A standard 10 cm (4 in.) coupler with reducer to 5 cm (2 in.) pipe.

4. A cylindrical type strainer.

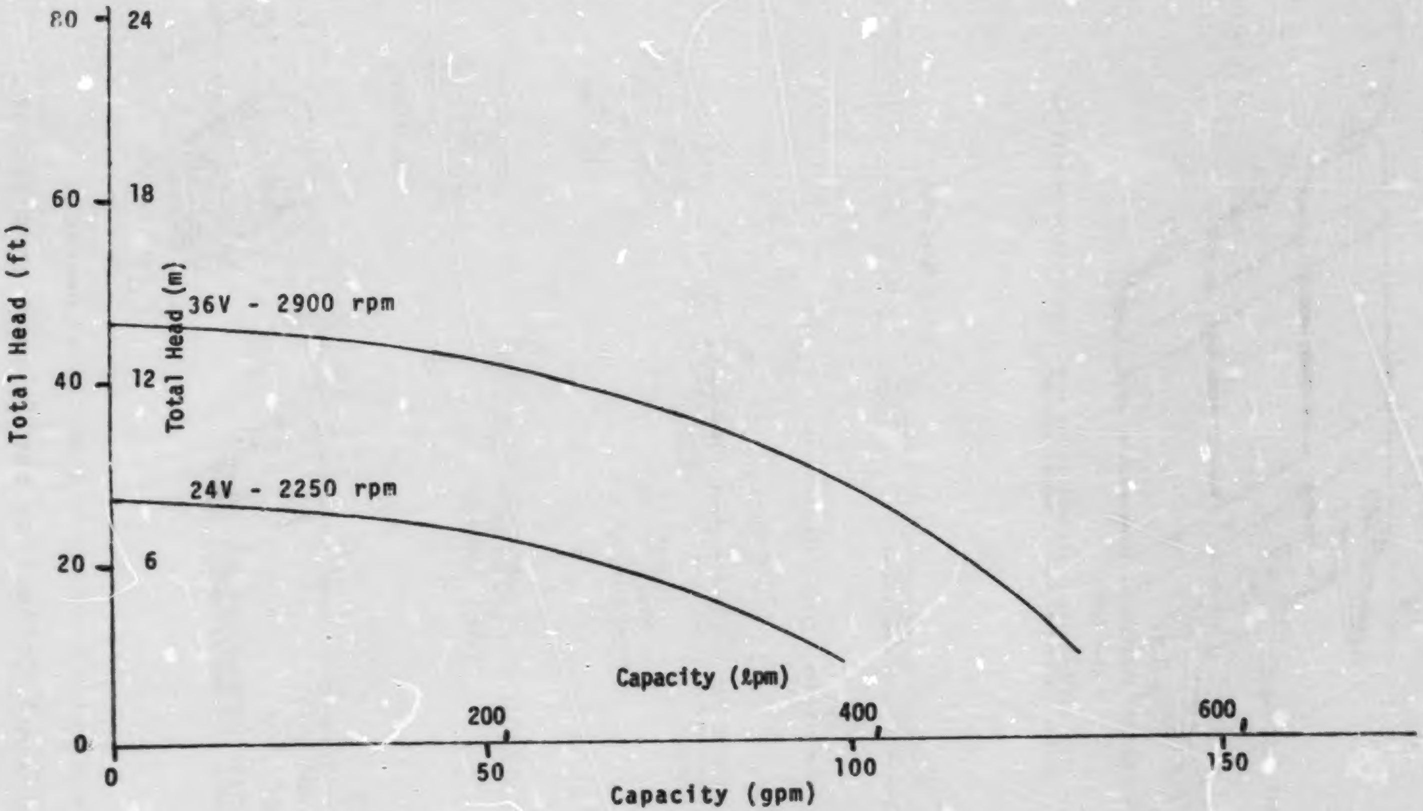
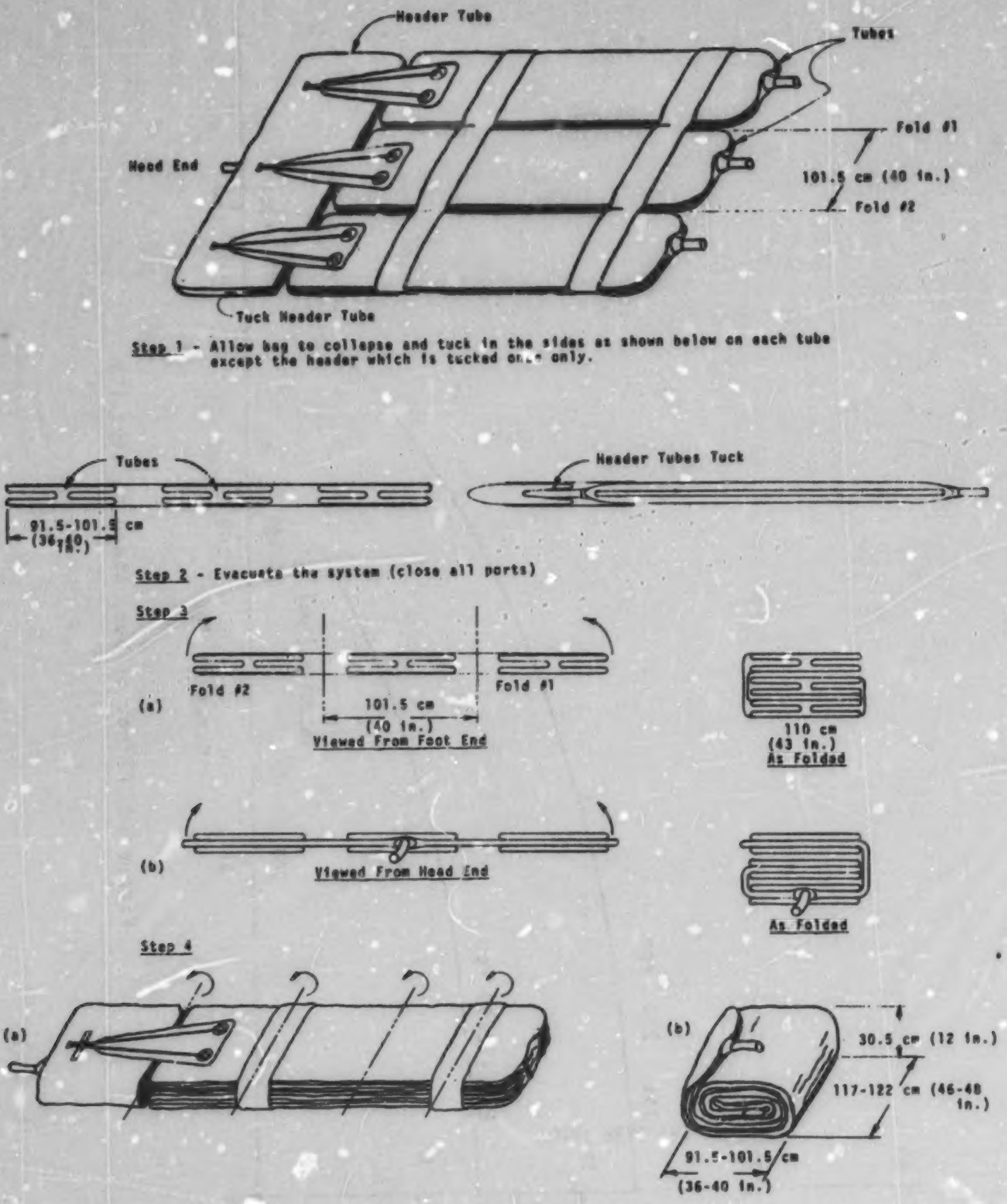


Figure A-3. Effect of pump speed on capacity


Header Tube
Tubes
Head End
Fold #1
101.5 cm (40 in.)
Fold #2
Tuck Header Tube
Tubes
Header Tubes Tuck
91.5-101.5 cm
(36-40 in.)
Fold #2
Fold #1
(a)
101.5 cm
(40 in.)
Viewed From Foot End
110 cm
(43 in.)
As Folded
(b)
Viewed From Head End
As Folded
(a)
(b)
30.5 cm (12 in.)
117-122 cm (46-48 in.)
91.5-101.5 cm
(36-40 in.)

Step 1 - Allow bag to collapse and tuck in the sides as shown below on each tube except the header which is tucked once only.

Step 2 - Evacuate the system (close all ports)

Step 3

Step 4

Fold up as required to a 122x91.5x122 cm (48x40x48 in.) dimension

Figure A-4. Collection bag folding arrangement

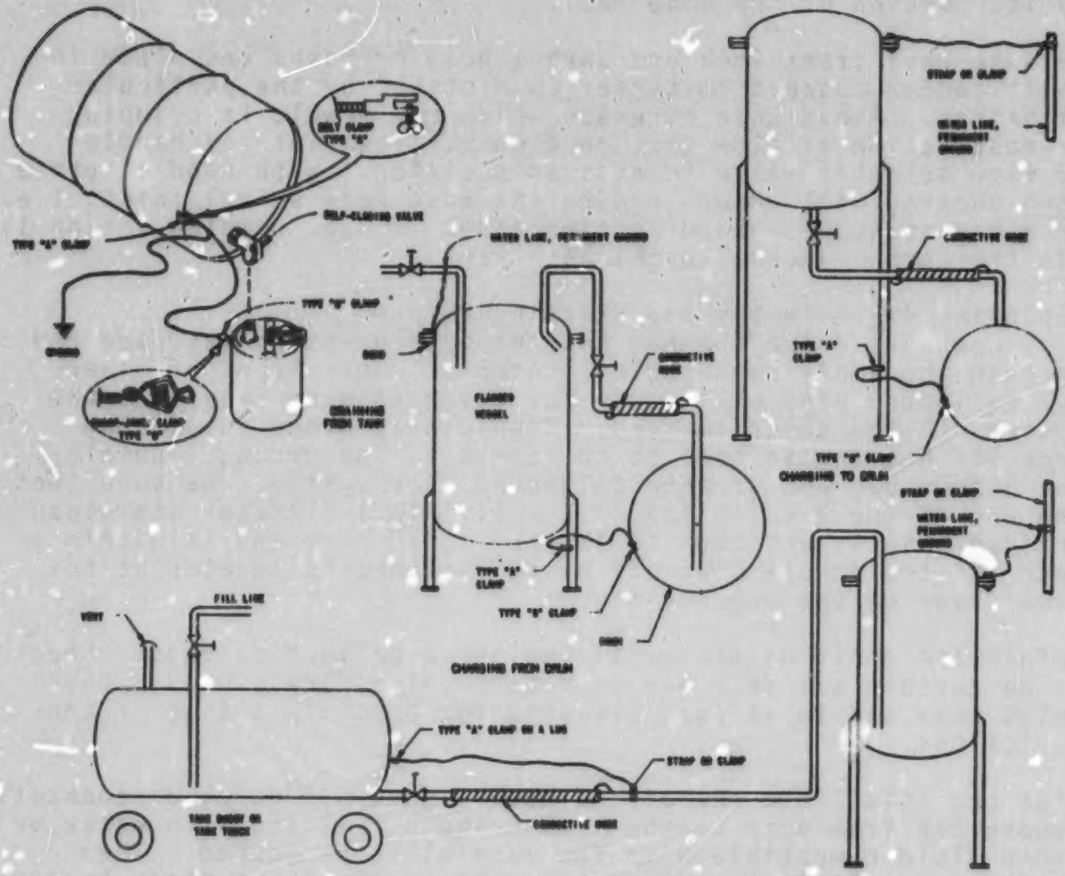

BOLT CLAMP
TYPE "B"
SELF-CLOSING VALVE
TYPE "A" CLAMP
WATER LINE, PERMANENT GROUND
TYPE "B" CLAMP
GROUND
BOSS
SPRING-JAW CLAMP
TYPE "B"
DRAINING FROM TANK
FLANGED VESSEL
CONDUCTIVE HOSE
STRAP OR CLAMP
WATER LINE, PERMANENT GROUND
CONDUCTIVE HOSE
TYPE "A" CLAMP
TYPE "B" CLAMP
CHARGING TO DRUM
STRAP OR CLAMP
WATER LINE, PERMANENT GROUND
TYPE "A" CLAMP
TYPE "B" CLAMP
DRUM
CHARGING FROM DRUM
VENT
FILL LINE
TYPE "A" CLAMP ON A LUG
STRAP OR CLAMP
TANK BODY ON TANK TRUCK
CONDUCTIVE HOSE

Figure A-5. Grounding techniques

5. A beveled (45°) pipe nipple.

Select the desired fitting(s) and mount on the end(s) of the hose(s). The unattached hose may be connected to the system via the quick-coupling adapter located atop the selector valve adjacent to the reel. If only one section of hose is required, use the stainless braid hose and leave the neoprene hose coiled on its portion of the hose reel.

Release reel crank lock and unreel hose or hoses and place in spill and/or connect to tanker as dictated by the particular situation. Avoid hose stresses which may result in crimping or restriction of flow through a hose. Then set red handle of flow selector valve in desired position. With handle turned down pumping will occur through the hose reel swivel joint, i.e., from the stainless braid suction hose. If up, pumping action is via the port adjacent to the hose reel.

Deploying Bag Assembly and Starting Pump--
Open the cover the bag housing by depressing latching rod through the small round hole located at upper front of cover. Spring loaded pins will cause the cover to drop away from the system. Allow cover to drop. Then gently nudge folded bag from its housing so that it too drops to the ground. Unfold the header bag and arrange on ground near system. Be sure that the end of the 3 m (10 ft), 3.8 cm (1.5 in.) diameter stainless braided hose is attached to the bag inlet port and is within reach of the double shut off quick disconnects located at the lower rear of the bag housing.

Unfold and position the remaining three collection bags. Check to be certain all four bag exit port valves are closed. Check inlet hose and inlet port sleeving for possible twists or constrictions.

Plug bag inlet into one of the double shut off quick disconnects. Remove cap from pump chamber and prime by filling with water or other fluid compatible with the mateial to be pumped. Then start pump. It is important that all of the above steps be taken before starting the pump. Pump starter is located at the explosion-proof box located on the pallet next to the hose reel. To start, turn selector know on starter to "RUN" and then depress the "START" button (located just below the selector switch) momentarily until the pump motor starts. Note: When pumping from two points, simultaneously or alternately, pumping of the lower elevation site should be started first.

Filling the Bag--
The bag will fill unattended, however, certain checks during this period may prove helpful, such as:

1. See that no large stresses develop in the bag material or its strap-anchors due to terrain features. A large rock or board support may relieve such a stress point.

2. Check closures on exit ports to insure against leaks.

3. Pay attention to the low voltage alarm. If battery voltage drops to a dangerously low level the high pitched audible alarm and flashing red light will be actuated. If the batteries are fully charged at the start of the run, the voltage should be maintained at acceptable levels for at least two hours. An exception to this might be the pumping of a rather viscous or lumpy material.

Accelerated Pumping--

By changing the battery harness wires as shown in Figure A-6 the speed of rotation of the pump shaft may be increased from ∿2250 rpm to ∿2900 rpm. This is accomplished by rearranging the batteries to provide 36 volts instead of 24 volts. IMPORTANT: The harness must be changed back to 24-volt operation before recharging the batteries.

Adding a Second Bag Assembly--

If a second bag assembly is required, its inlet hose may be connected to the second quick disconnect which is manifolded together with the first in the area just behind the bag housing. Do NOT disconnect first bag assembly without having a second bag connected unless pump motor is first stopped.

Auxiliary Pump Motor--

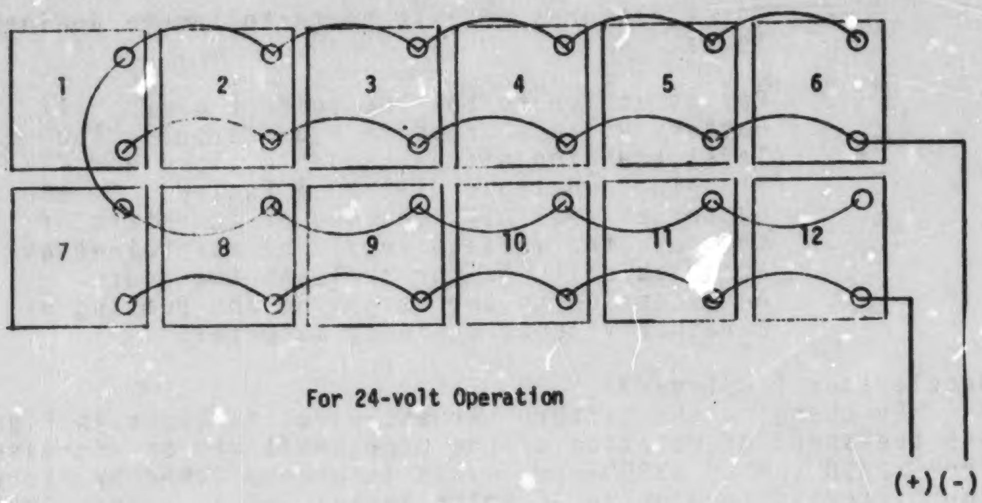
The pump motor may be operated directly from a battery charger/eleminator by removing the battery plug from the junction box located behind the batery pack housing and substituting the output plug from an eliminator. The eliminator used must be capable of providing 35 amperes at 24 volts DC.

Clean-up After Run--

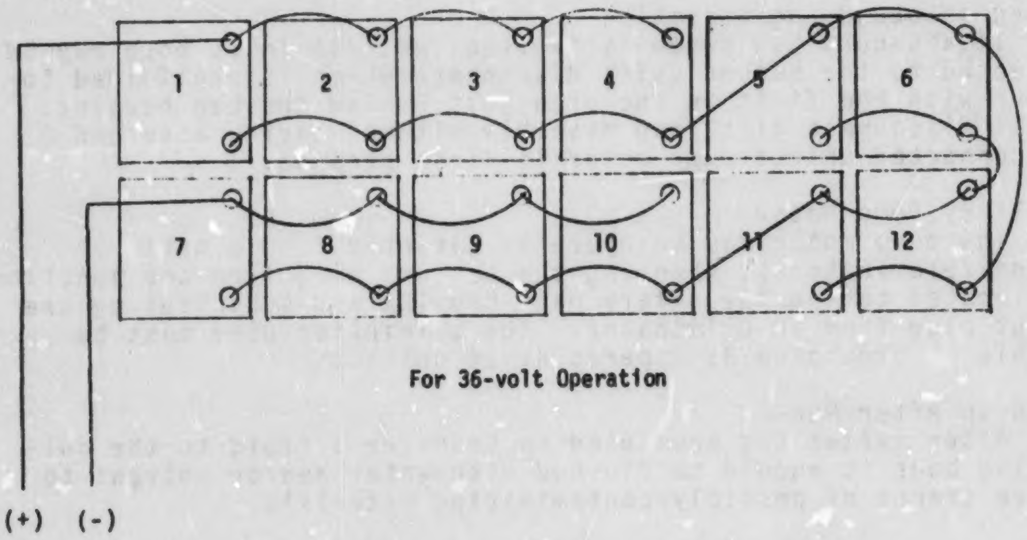
After system has been used to transfer a fluid to the collecting bags it should be flushed with water and/or solvent to remove traces of possibly-contaminating materials.

Recharging the Batteries--

Before attempting battery recharging be sure control panel selector switch is in the OFF position. Then plug float charger into the box housing the low voltage alarm. Adjust the voltage output to 27.3 volts. Turn selector switch to CHARGE. Readjust voltage output to 27.3 volts and adjust current limiting potnetiometer to about two amperes. Charging will continue until


1
2
3
4
5
6
7
8
9
10
11
12
(+)
(-)

For 24-volt Operation


1
2
3
4
5
6
7
8
9
10
11
12
(+)
(-)

For 36-volt Operation

Figure A-6. Harness Wire Rearrangement

current drops to zero. Charger may remain connected to the batteries to maintain a high level of charge. If charger is removed after charging is complete, the battery voltage level will hold for at least 90 days. When disconnecting the charger from the system first turn selector switch to OFF before shutting off charger power in order to avoid blowing a protective fuse in the starter/control box.

Trouble Shooting

Improper operation of the Emergency Collection System can occur due to several causes. The following instructions will be helpful in tracing the cause of a failure or improper system operation. Possible difficulties are listed in the sequence which they might be encountered in the course of operating the system.

A. Hose reel jammed:

- check crank locking wheel located at side of reel mount
- check for binding of hose(s) against a part of the system

B. Bag housing door will not open:

- probably due to twisting of the bag housing. Use screw driver or similar object to pry out top of door.

C. Pump will not start:

- check battery connections and voltage
- check for foreign objects in shaft and coupling area
- open motor starter control box and check fuses and overload heaters (see wiring diagram, Figure A-7)
- check for possible locked rotor by removing coupling guard and turning shaft by hand.

D. No charging current:

- check fuses in starter control box. Selector switch must be in OFF position until input power is applied to the charging unit.

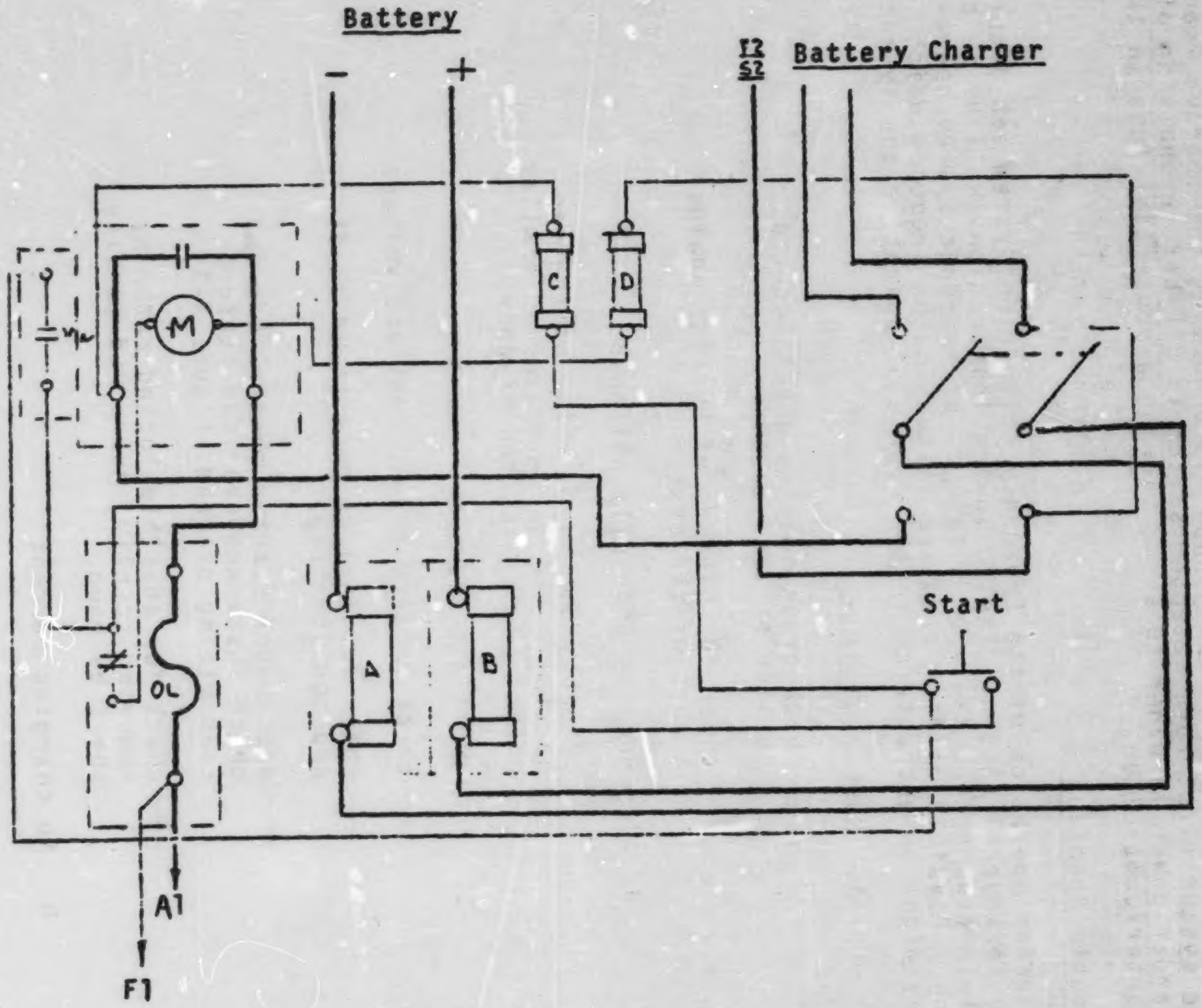

Battery
-
+
T2
S2
Battery Charger
C
D
M
Start
A
B
OL
A1
F1

Figure A-7. Motor starter wiring diagram

- check for open circuits in battery wiring
- check power cord from 115V AC line.

Maintenance

No general maintenance should be required other than to clean the hoses and pump lines after use and keep the batteries charged as discussed earlier. A repair kit for the bag is included with the system which contains various types of hose sealers. Maintenance on specific system components should be performed as directed by the supplier, or by returning the unit to the vendor for servicing.

A parts list that includes all components and major units is provided in Table A-1. Specific manuals to be consulted are reproduced in the following catalog sheets.

Table A-1. PARTS LIST FOR BATTERY-POWERED MODEL

Item	Description	Part No.	Required	Supplier
1	Fluid Bag - Shelterlite	(Special)	1 ea	Sargent Industries - PICO Division
2	1 HP Motor - Explosion Proof	541A-9210	1 ea	Reliance Electric Co.
3	Self-priming Centrifugal Pump	1-1/2 HE19 EL-316 SS	1 ea	Marlow Pumps Div., Int'l. Tel. & Tel. Corp.
4	Gel/Cell Rechargeable Battery	GC12200	12 ea	Globe Battery Div., Globe Union, Inc.
5	Power Supply, 0-28V DC	UN1-30F	1 ea	Power Mate Corp.
6	Starter, 1 HP, 25 volt	14679	1 ea	Control Products Co.
7	Voltsensor Battery Monitor	325	1 ea	Calex Corp.
8	Hose Reel with Divider	8234-33-34	1 ea	C.B. Hannay & Sons
9	5 cm (2 in.) Gatron Hose, Male NPT SS	45HW	15.25 m (50 ft)	Gates Rubber Co.
10	5 cm (2 in.) Hose, Male NPT SS Fittings Viton Gaskets	R267	15.25 m (50 ft)	Titeflex Div., Atlas Corp.
11	3.8 cm (1.5 in.) Hose-One Male SS NPT and	R267	3 m (10 ft)	Titeflex Div., Atlas Corp.
12	Strainer, SS with Screen	BXS	1 ea	Anderson-IBEC
13	3-way Ball Valve, SS, 5 cm (2 in.) NPT Female, Teflon Seals	---	1 ea	Worcester Valve Co.

(continued)

Table A-1 (continued)

Item	Description	Part No.	Required	Supplier
14	3.8 cm (1.5 in.) Lateral, SS			Any
15	Panel Meter	1029610	1 ea	Triplet Co.
16	Sonalert Audible Alarm	SC628	1 ea	Mallory Co.
17	Drum Faucet, Polyethylene	230213	4 ea	Plastic Piping System
18	5 cm (2 in.) Quick Coupling	Type A	2 ea	Evertite Coupling Co.
19	Coupler, SS, 10 cm x 5 cm (4 in. x 2 in.) NPT Bushing	Special	1 ea	Shields Rubber Co.
20	Strainer, Brass, 0.5 cm (.20 in.) holes, 5 cm (2 in.) Male NPT	Special	1 ea	Shields Rubber Co.
21	Quick Disconnect Socket	LL-12-H46-143	2 ea	Hansen Mfg. Co.
22	Quick Disconnect Plug	LL-12-K46-143	2 ea	Hansen Mfg. Co.
23	Door Locking Mechanism	Special	1 set	P.D. Hoffman

STARTER SPECIFICATION SHEET

SOLD TO M. S. A.

H.P. 1 H.P.

VOLTAGE 25 Volts

PTS. ACCEL. Across the Line

REV. OR NON REV. Non-Rev. P. O. 25203

WIRING DIAGRAM C-14683 TYPE 14679

SERIAL NO. 1

X/P

SYMBOL	QTY.	DESCRIPTION	PART NO.	CPL NO.
	1	Starter Assembly		14679
	1	Case Weldment		14680
	1	Cover Assembly		14681
	1	Cover Details		14681-1
		P/B Operator Assy.		10128-2
	1	Black Cap		10068-1
	1	Boss		10126
	1	Shaft		10070
	2	Retaining Ring		10069
	1	Selector Switch	DPDT 103702A-3	14456
	1	Sel. Mtg. Pad		14675
	1	Boss		10067
		Panel Assembly		14682
	1	Panel Details		14682-1
	1	Contactor	H31D241L0	14490
	1	Overload Relay	AN31P	10122x5
	1 Set	H-83 Heaters		10049x7

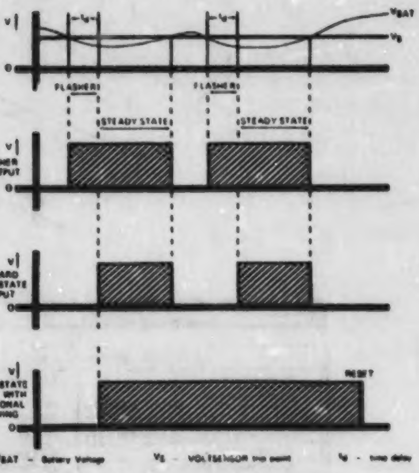
Model 365 VOLTSENSOR Battery Monitor
SPECIFICATIONS

Power Required:	9-50VDC
Trip Point Range:	Adjustable from 9VDC-50VDC
Resolution:	0.1% full scale
Repeatability & Sensitivity:	0.1% full scale
Trip Point Stability:	Less than 0.1%/°C
Input Overload:	±100 Volts continuous
On-Off Differential:	1% full scale – (other values available)
Output:	Two separate outputs. The first is an oscillating output, suitable for a flashing light, which is triggered as soon as the trip point is reached. The second is a steady state output designed for throwing a relay. It is not triggered until the time delay period has been exceeded. Both outputs are approximately the battery voltage at up to 100 ma.
Time Delay:	Adjustable from 1/10 sec. to 5 min. (nominal)
Operating Temperature:	−25°C to +75°C
Size:	1"(w) x 3"(l) x 2.6"(h)
Weight:	12 oz.
Price:	$78.00 (Attractive quantity and OEM discounts available.) F.O.B. Factory.

MODIFICATIONS

1. "325" Does not have the time delay or the flasher. Otherwise identical to 365 – $48.00 F.O.B. Factory
2. "365-L" "325-L" Latching – $5.00 additional
3. "365-M" "325-M" Magnetic trip stays tripped even if power is interrupted – $10.00 additional
4. "365-5" "325-5" Output reversed – $5.00 additional
5. Combinations of the above modifications are available on the same unit.

VOLTSENSOR OPERATION


V
0
t_d
V_{BAT}
V_S
FLASHER
STEADY STATE
FLASHER
STEADY STATE
V
FLASHER OUTPUT
0
V
STANDARD STEADY STATE OUTPUT
0
V
STEADY STATE OUTPUT WITH OPTIONAL LATCHING
0
RESET
V_{BAT} – Battery Voltage
V_S – VOLTSENSOR trip point
t_d – time delay

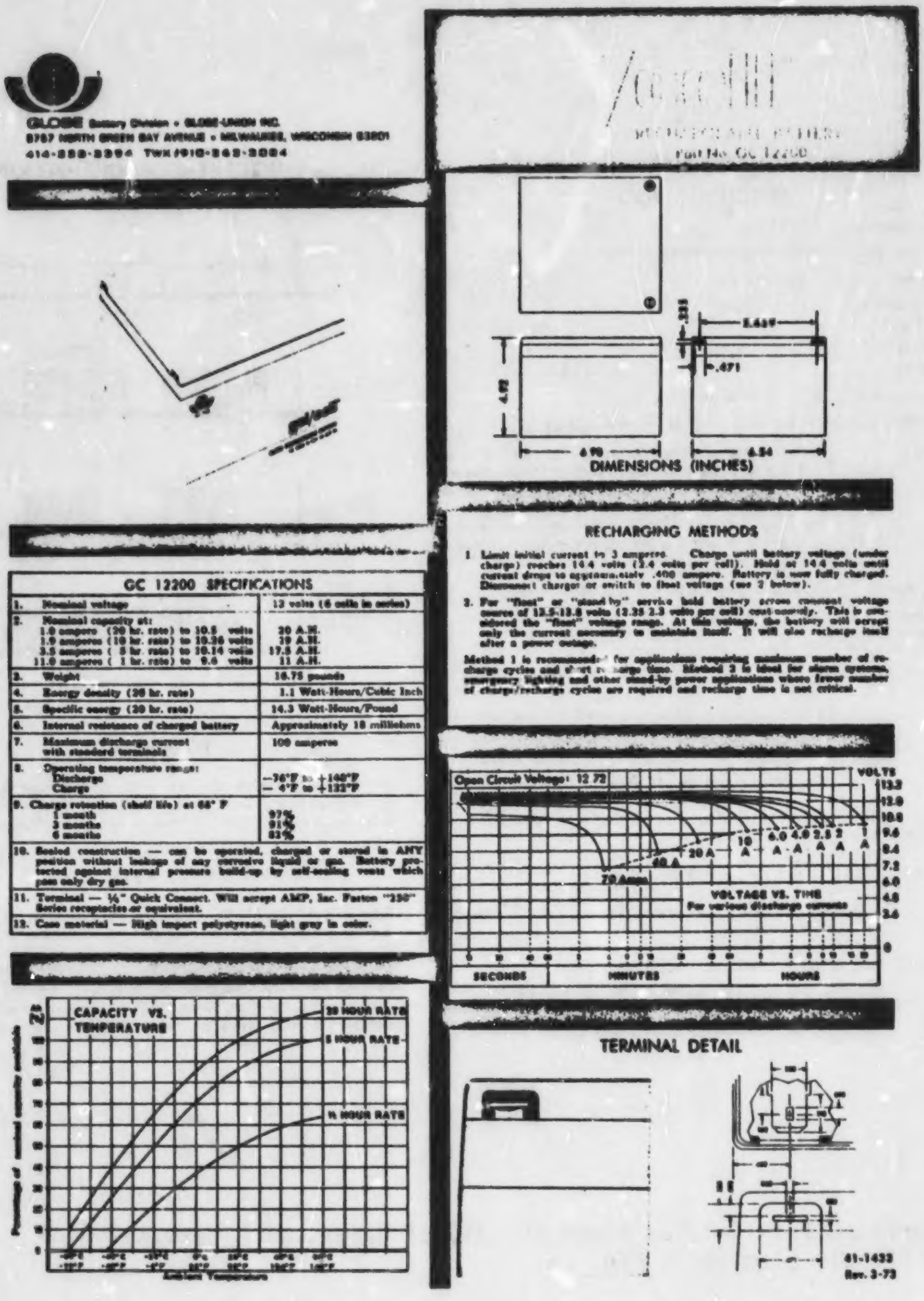
WARRANTY

All CALEX products are warranted during a period of one year from date of shipment to be free from defects in material and workmanship. Liability is limited to repair or replacement.

REPAIR POLICY

Because the VOLTSENSOR Battery Monitor is completely encapsulated in epoxy, it is not considered to be repairable. If a unit appears to be malfunctioning, check all external connections carefully. If the malfunction still appears to be in the VOLTSENSOR, it should be returned to the factory for analysis of failure. If the unit is determined to be in warranty, it will be replaced. If not, notification will be sent along with a "trade-in" value of the damaged unit.

Reprinted from Catalog Sheet No. 315 of Calex, with permission of California Electronic Mfg. Co.



GLOBE Battery Division • GLOBE-UNION INC.
5757 NORTH GREEN BAY AVENUE • MILWAUKEE, WISCONSIN 53201
414-228-2394 TWX (910-262-3084

RECHARGEABLE BATTERY
Part No. GC 12200

GC 12200 SPECIFICATIONS	
1. Nominal voltage	12 volts (6 cells in series)
2. Nominal capacity at: 1.0 ampere (20 hr. rate) to 10.5 volts 1.9 amperes (10 hr. rate) to 10.26 volts 3.5 amperes (5 hr. rate) to 10.14 volts 11.0 amperes (1 hr. rate) to 9.6 volts	 20 A.H. 19 A.H. 17.5 A.H. 11 A.H.
3. Weight	16.75 pounds
4. Energy density (20 hr. rate)	1.1 Watt-Hours/Cubic Inch
5. Specific energy (20 hr. rate)	14.3 Watt-Hours/Pound
6. Internal resistance of charged battery	Approximately 18 milliohms
7. Maximum discharge current with standard terminals	100 amperes
8. Operating temperature range: Discharge Charge	 −76°F to +140°F − 4°F to +122°F
9. Charge retention (shelf life) at 68° F 1 month 3 months 6 months	 97% 91% 82%
10. Sealed construction — can be operated, charged or stored in ANY position without leakage of any corrosive liquid or gas. Battery protected against internal pressure build-up by self-sealing vents which pass only dry gas.	
11. Terminal — ¼" Quick Connect. Will accept AMP, Inc. Faston "250" Series receptacles or equivalent.	
12. Case material — High impact polystyrene, light gray in color.	

DIMENSIONS (INCHES)

RECHARGING METHODS

1. Limit initial current to 3 amperes. Charge until battery voltage (under charge) reaches 14.4 volts (2.4 volts per cell). Hold at 14.4 volts until current drops to approximately .400 ampere. Battery is now fully charged. Disconnect charger or switch to float voltage (see 2 below).

2. For "float" or "stand-by" service hold battery across constant voltage source of 13.5-13.8 volts (2.25-2.3 volts per cell) continuously. This is considered the "float" voltage range. At this voltage, the battery will accept only the current necessary to maintain itself. It will also recharge itself after a power outage.

Method 1 is recommended for applications requiring maximum number of recharge cycles and short recharge time. Method 2 is ideal for alarm systems, emergency lighting and other stand-by power applications where fewer number of charge/recharge cycles are required and recharge time is not critical.

TERMINAL DETAIL

5.437
.471
4.92
6.90
6.54
Open Circuit Voltage: 12.72
VOLTS
13.2
12.0
10.8
9.6
8.4
7.2
6.0
4.8
3.6
0
70 Amps
40 A
20 A
10 A
6.0 A
4.0 A
2.5 A
2 A
1 A
VOLTAGE VS. TIME
For various discharge currents
SECONDS
MINUTES
HOURS
CAPACITY VS. TEMPERATURE
20 HOUR RATE
5 HOUR RATE
½ HOUR RATE
Ambient Temperature
41-1433
Rev. 3-73

Reprinted from Catalog Sheet for Part No. GC 12200 with permission of Globe Battery Division, Globe-Union Inc.

POWER SUPPLY OPERATING INSTRUCTIONS

1.0 GENERAL

All Power/Mate power supplies are carefully inspected and tested to insure conformance to our published specifications as stated in the catalog. However, to insure satisfactory performance and long life, it is important to operate and maintain the power supply properly in accordance with these instructions.

2.0 POWER SUPPLY MOUNTING

All Power/Mate supplies are designed for convention cooling. However, it is important not to impede the air flow across and through the power supply case. Heat is the primary cause of failure in any piece of electronic equipment. Impeding the flow of convection air through your power supply may result in a shortening of the long-life designed into by Power/Mate.

Conversely, forced air, from a small fan, through the heat generating components of the power supply, can overcome any impediment of the natural convention air flow. If there is any doubt as to the amount of convection air flow through your Power/Mate power supply, the use of a small fan to insure a satisfactory air flow is recommended.

When chassis mounting any Power/Mate power supply using the bottom mounting holes, make sure that the ventilation holes in the power supply chassis are not covered by the mounting chassis. The mounting chassis should have cut-outs approximating the ventillating holes in the power supply. This permits the normal air convection throught the power supply.

An alternative method to permit proper air convection current is to provide a 1/2 inch space (minimum) between the power supply and the mounting chassis.

Detailed mounting and outline dimensions for most Power/Mate power supplies are given in the general Power Mate power supply catalog.

3.0 OUTPUT VOLTAGE ADJUSTMENTS

The output of most Power/Mate power supplies can be adjusted simply by monitoring the output voltage on a meter placed across the output terminals or by means of the front panel meter (where applicable.)

Many power supplies have both a coarse and fine voltage control to more accurately set the output voltage.

3.1 UNI SERIES POWER SUPPLY OUTPUT ADJUSTMENT

All UNI Series (universal series) power supplies as shipped from the factory are set for a nominal 5 volts output. These power supplies may be set for any output from zero to 30 volts by the following procedure:

1. Remove the cover on case size A, B, and BB. Remove the rear panel on case size C through H.
2. Select the proper tap for the desired output voltage range. The voltage range for each tap is indicated on the transformer.
3. Set coarse and fine voltage controls (accessible from terminal block side of power supply) to nominal center position.
4. Make sure + (pos.) terminal and + sense terminal are connected together. Similarly, make sure - (neg.) terminal and - sense term are connected together.
5. Connect 115 volt to AC input terminals.
6. Connect an accurate meter to DC output terminals of power supply.
7. Adjust the coarse voltage control to the desired output voltage.
8. Turn off the AC, replace the cover or rear panel. The fine voltage control may be used to more accurately adjust the output voltage to the precise desired value.

CAUTION

THE POWER SUPPLY MAY BE DAMAGED IF THE COARSE CONTROL IS SET TO OPERATE THE POWER SUPPLY OUTSIDE OF THE VOLTAGE RANGE LIMITS NOTED ON THE TRANSFORMER TAP RANGE SETTING INSIDE OF THE POWER SUPPLY.

4.0 LOCAL-REMOTE LOAD SENSING

Many power supplies have the remote local load sensing feature. This feature is available on power supplies with +sense and -sense terminals marked on the terminal block. Power supplies shipped from the factory are normally connected for local sensing. Connections for remote or local load sensing is shown in Fig. 1.

Reprinted from operating instruction for regulated power supply, Power/Mate Corporation.

5.0 OUTPUT CURRENT ADJUSTMENT

On power supplies with an output current limit control, this may be adjusted as follows:

Connect an ammeter across the output terminals of the power supply. Use an ammeter with a range greater than the desired current limit setting. Remove all other loads from the power supply. Apply AC to the input of the power supply and adjust the current limit control to the desired current as indicated on the ammeter. This adjustment limits the output current from the power supply under all load conditions.

CAUTION

Make sure that this current setting is within the ratings of the power supply otherwise overheating and possible damage may occur to your power supply. Make certain that the power supply output voltage is set to the normal output voltage under normal or open circuit load conditions, before adjusting the current setting. Make sure the current setting is set beyond the "knee" of the current setting, otherwise the voltage regulation of the power supply may be affected.

On power supplies with front panel meters, it is only necessary to short circuit the output of the power supply. The current adjust may be set to the desired current limit as indicated on the front panel meter.

6.0 OVERVOLTAGE ADJUSTMENT

Many Power/Mate power supplies have overvoltage protection built-in to the power supply. This unit is also available as a separate unit.

The adjustment and checking of the overvoltage feature can be accomplished as follows:

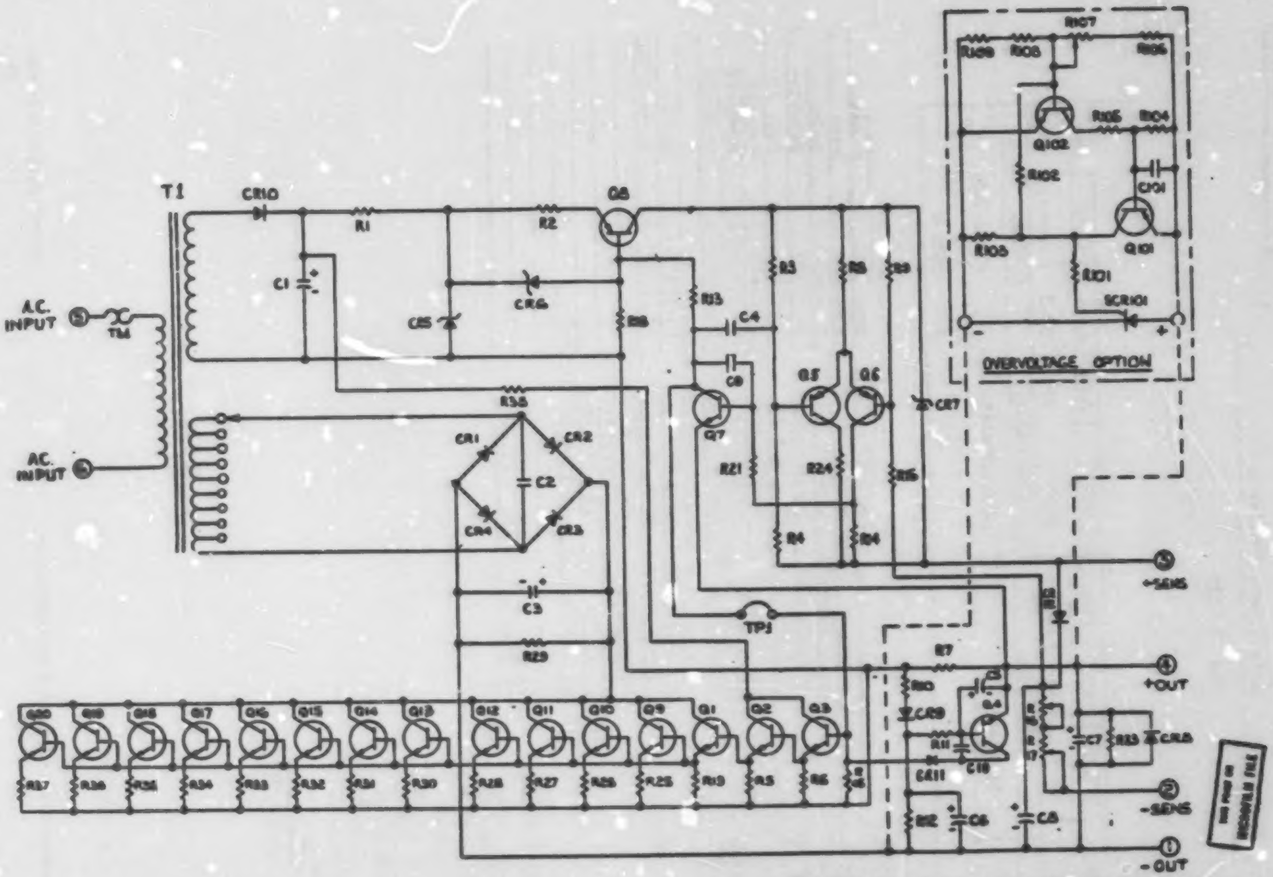
Set the overvoltage adjustment to the highest voltage setting. Set the power supply output voltage to the desired overvoltage set point and monitor the output on a voltmeter. Typically, the overvoltage set point is at least 15% plus one volt above the normal output voltage of the power supply. This prevents spurious triggering of the OVP from external transients. Turn the overvoltage control slowly until the output voltage of the power supply drops from the set point to approximately 0.6 volts. Turn off power for 15 seconds and readjust power supply voltage controls to normal setting. Re-apply power and readjust output voltage to normal output voltage.

In the event that the power supply cannot be adjusted to the desired overvoltage set point, an externally adjustable power supply connected across the output terminals of the power supply may be used.

Under certain conditions, the AC input current can become large when the overvoltage protector operates. It is recommended the following fuse rating be used in the AC input lead to the power supply.

$$\text{Input fuse rating, Slo-blo type} = \frac{\text{Output voltage} \times \text{output current} \times 4}{\text{Nominal line voltage}}$$

Reprinted from operating instruction for regulated power supply, Power/Mate Corporation.


T1
CR10
R1
R2
Q8
C1
CR5
CR6
R18
R13
C4
C8
Q7
R3
R5
R9
Q5
Q6
CR7
R21
R24
R15
R4
R14
R35
CR1
CR2
C2
CR4
CR3
C3
R29
TP1
A.C. INPUT ⑤
TM
A.C. INPUT ⑥
R7
R10
CR9
R11
C10
Q4
CA11
R12
C6
C5
C7
R33
CR8
⑤ +SENS
④ +OUT
② -SENS
① -OUT
Q20
Q19
Q18
Q17
Q16
Q15
Q14
Q13
Q12
Q11
Q10
Q9
Q1
Q2
Q3
R37
R36
R35
R34
R33
R32
R31
R30
R28
R27
R26
R25
R13
R5
R6
R109
R108
R107
R106
R105
R104
Q102
R102
C101
Q101
R103
R101
SCR101
OVERVOLTAGE OPTION
POWER/MATE CORP.
FRY-UNI-30-F,G,H
SCHEMATIC DIAGRAM
C
61-21868

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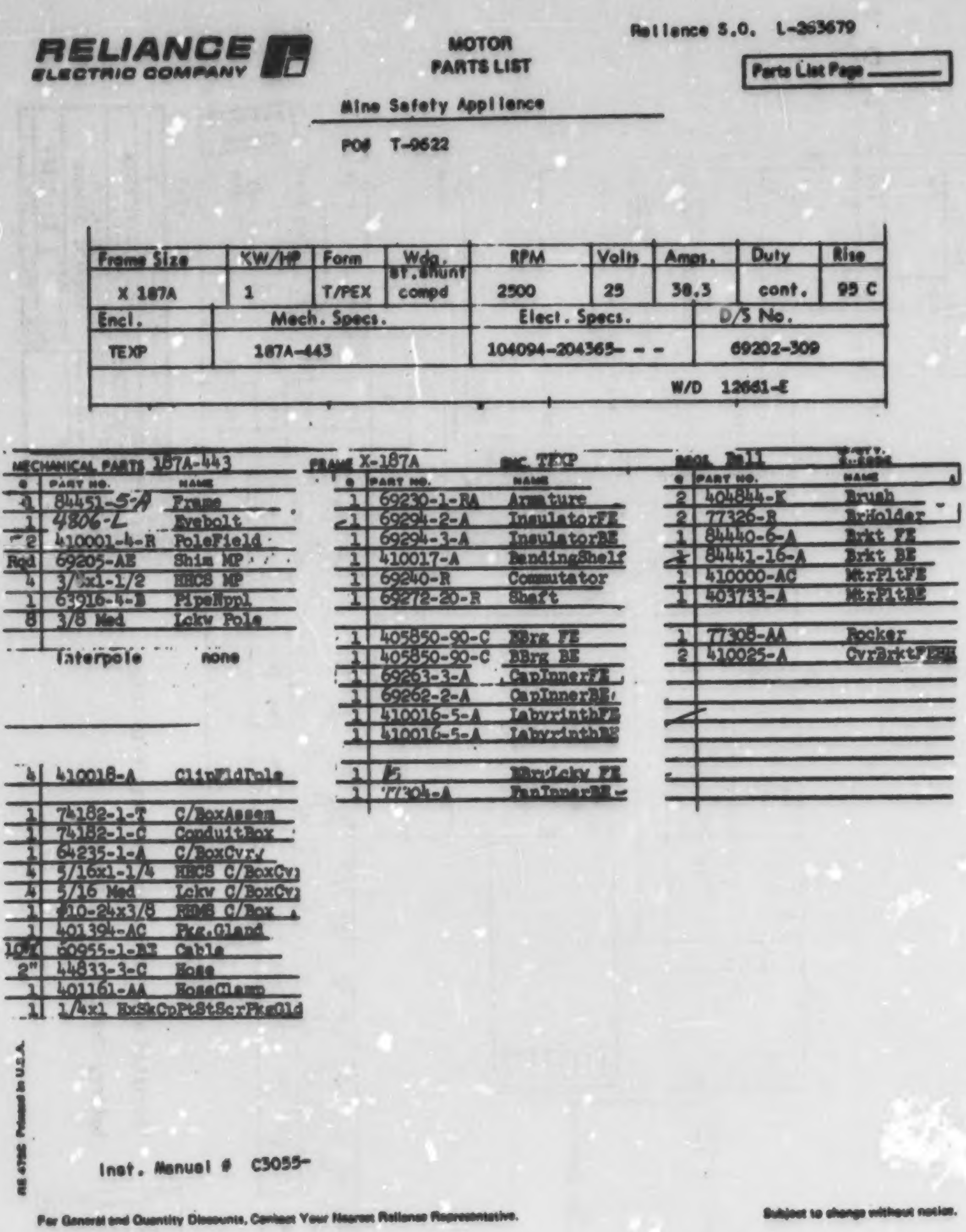
Battery Charger Wiring Diagram



RELIANCE ELECTRIC COMPANY

MOTOR PARTS LIST

Reliance S.O. L-263679

Parts List Page ______

Mine Safety Appliance

PO# T-9622

Frame Size	KW/HP	Form	Wdg.	RPM	Volts	Amps.	Duty	Rise
X 187A	1	T/PEX	St.Shunt compd	2500	25	38.3	cont.	95 C

Encl.	Mech. Specs.	Elect. Specs.	D/S No.
TEXP	187A-443	104094-204365- - -	69202-309
			W/D 12661-E

MECHANICAL PARTS 187A-443

Q	PART NO.	NAME
1	84451-5-A	Frame
1	4806-L	Eyebolt
2	410001-4-R	PoleField
Rqd	69205-AE	Shim MP
4	3/8x1-1/2	HHCS MP
1	63916-4-B	PipeNppl
8	3/8 Med	Lckw Pole
	Interpole	none
4	410018-A	ClipFldPole
1	74182-1-T	C/BoxAssem
1	74182-1-C	ConduitBox
1	64235-1-A	C/BoxCvr
4	5/16x1-1/4	HHCS C/BoxCvr
4	5/16 Med	Lckw C/BoxCvr
1	#10-24x3/8	RHMS C/Box
1	401394-AC	Pkg.Gland
10'	60955-1-BT	Cable
2"	44833-3-C	Hose
1	401161-AA	HoseClamp
1	1/4x1	HxSkCpPtStScrPkgGld

FRAME X-187A ENC. TEXP

Q	PART NO.	NAME
1	69230-1-RA	Armature
1	69294-2-A	InsulatorFE
1	69294-3-A	InsulatorBE
1	410017-A	BandingShelf
1	69240-R	Commutator
1	69272-20-R	Shaft
1	405850-90-C	BBrg FE
1	405850-90-C	BBrg BE
1	69263-3-A	CapInnerFE
1	69262-2-A	CapInnerBE
1	410016-5-A	LabyrinthFE
1	410016-5-A	LabyrinthBE
1	#5	BBrgLckw FE
1	77304-A	FanInnerBE

BRGS. Ball

Q	PART NO.	NAME
2	404844-K	Brush
2	77326-R	BrHolder
1	84440-6-A	Brkt FE
1	84441-16-A	Brkt BE
1	410000-AC	MtrPltFE
1	403733-A	MtrPltBE
1	77308-AA	Rocker
2	410025-A	CvrBrktFEBE

Inst. Manual # C3055-

RE 4795 Printed in U.S.A.

For General and Quantity Discounts, Contact Your Nearest Reliance Representative.

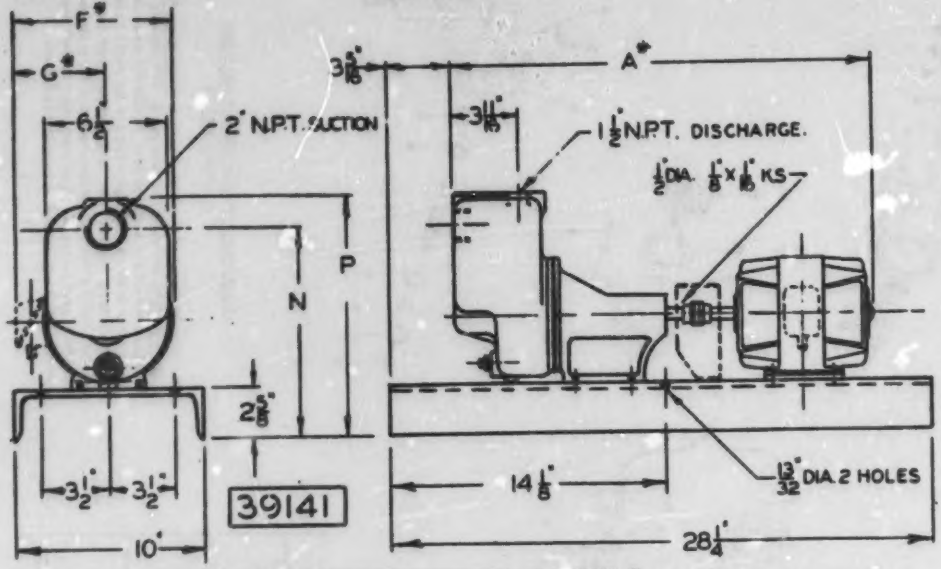
Subject to change without notice.

Reprinted from Parts List, with permission of Reliance Electric Co.

SECTION 380 - PAGE 44

DIMENSIONS

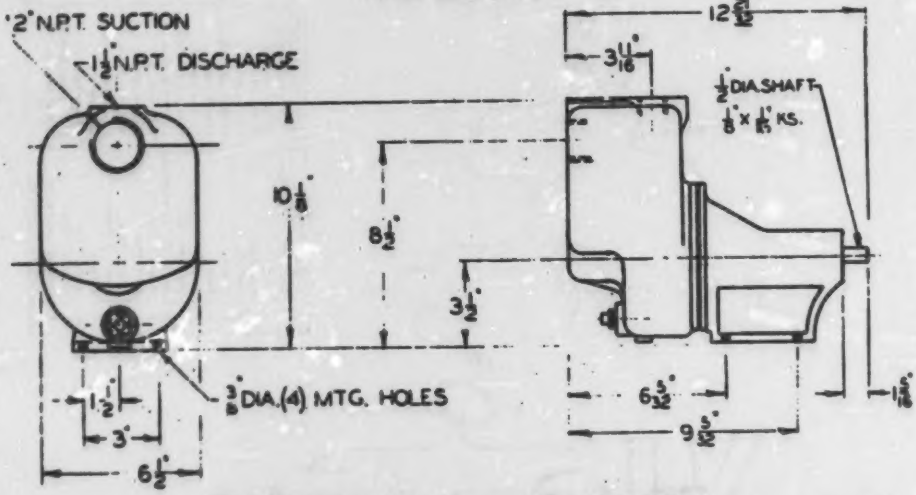
MODEL 1-1/2HE19EL-BASE MOUNTED
Long Coupled Pump


F*
G*
6 1/2"
2" N.P.T. SUCTION
P
N
2 5/8"
3 1/2"
3 1/2"
10"
39141
3 5/16"
A*
3 11/16"
1 1/2" N.P.T. DISCHARGE.
1/2" DIA. 1/8" x 1/16" KS
14 1/8"
13/32" DIA. 2 HOLES
28 1/4"

MOTOR FRAME	A*	N	P	F*	G*
56, 143T, 145T	24 7/8	11 1/8	12 3/4	9 1/2	6
182T, 184T	28 1/4	12 1/8	13 3/4	12 1/8	7 3/4

*DIM'S MAY VARY DEPENDING ON MOTOR MFR.

PUMP END ONLY


2" N.P.T. SUCTION
1 1/2" N.P.T. DISCHARGE
10 1/8"
8 1/2"
3 1/2"
1 1/2"
3"
6 1/2"
3/8" DIA.(4) MTG. HOLES
12 21/32"
3 11/16"
1/2" DIA. SHAFT
1/8" x 1/16" KS.
6 5/32"
9 5/32"
1 5/16"

THESE DIMENSIONS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED. Printed in U.S.A.

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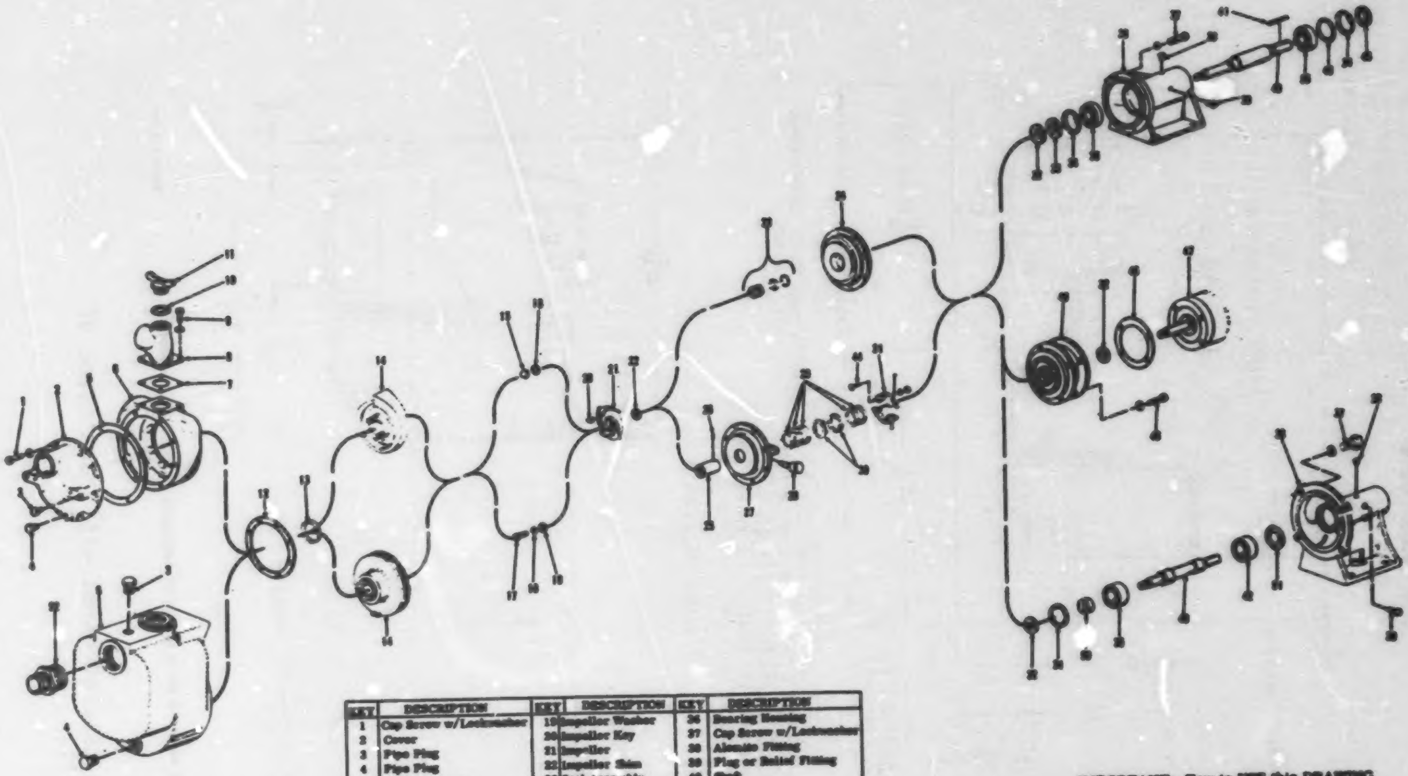
Marlow Pumps ITT.



KEY	DESCRIPTION	KEY	DESCRIPTION	KEY	DESCRIPTION
1	Cap Screw w/Lockwasher	19	Impeller Washer	36	Bearing Housing
2	Cover	20	Impeller Key	37	Cap Screw w/Lockwasher
3	Pipe Plug	21	Impeller	38	Alemite Fitting
4	Pipe Plug	22	Impeller Shim	39	Plug or Relief Fitting
5	Gasket, Cover	23	Seal Assembly	40	Shaft
6	Tank	24	Seal Plate	41	Key, Input
7	Gasket, Discharge	25	Shaft Sleeve	42	Ball Bearing
8	Discharge Tee	26	Sleeve Lock Pin	43	Bearing Shim
9	Cap Screw w/Lockwasher	27	Packing Plate	44	Carriage Bolt
10	Gasket, Filler	28	Grease Cup	45	Bearing Cap
11	Filler Plug	29	Packing, Set	46	Lantern Shim
12	Gasket, Tank	30	Grease Rings, Pair	47	Motor
13	Gasket, Diffuser	31	Gland Assembly	48	Cap Screw w/Lockwasher
14	Diffuser	32	Slinger	49	Lantern
15	Impeller Nut	33	Bearing Cap	50	Bearing Spacer
16	Impeller Washer	34	Retaining Ring	51	Finger Spring
17	Impeller Lock Screw	35	Ball Bearing	52	Adapter or Reducer
18	Impeller Lockwasher				

35624-3

IMPORTANT: How to USE this DRAWING to ORDER PARTS

The above grouping of parts illustrations cover many different Marlow models, including your own pump. The table on the left page indicates the name of each part. Should you need a replacement, refer to above drawings - locate the part that matches your pump part. Contact your local Marlow dealer and supply him with the Key Number and Description of the parts required, along with your pump Model number, Spec number and Serial number, which are located on the pump nameplate.

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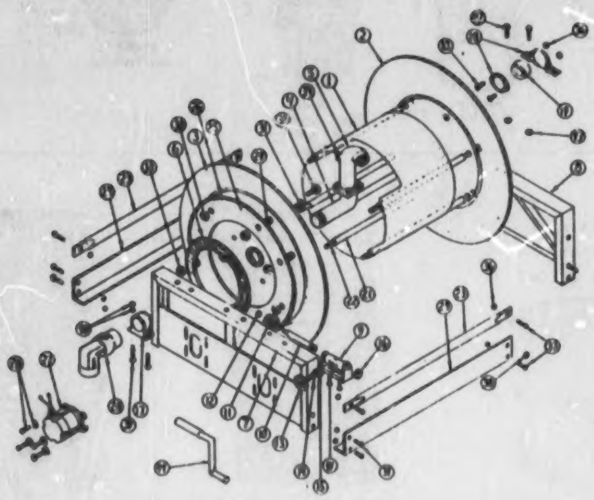
HANNAY REELS

CLIFFORD B. HANNAY & SON, INC., WESTERLO, NEW YORK 12193
TELEPHONE (518) 797-3791

PARTS LIST
2" HOSE REELS
WITH
BALL BEARING SWIVEL JOINT

Drawing ISO-35



When ordering parts,
BE SURE TO SPECIFY COMPLETE MODEL NUMBER and SERIAL NUMBER OF REEL

Drawing Number	Description	Quantity Required
1	Drum	1
2	Back Disc	1
3	Front Disc	1
4	Hub	1
5	Riser	1
6	Ring Gear H-28*	1
7	Front Frame with Motor Mount	1
8	Back Frame	1
9	H-2A Side Pinion Bearing	1
10	Pinion Shaft	1
11	Pinion Gear H-29	1
12	Lock Nut	1
13	Brake Wheel H-30A	1
14	Brake Spring H-31	1
15	Brake Pad H-3	1
16	Collar & Set Screw	1
17	Front Bearing [illegible]	1
18	Bearing Holder	1
19	Self-aligning Bearing	1
20	2" Swivel Joint	1
21	Spacer Pipe	10
22	Carriage Bolt	10

Drawing Number	Description	Quantity Required
23	Brace	2
24	Foot	2
25	Disc Sprocket	1
26	Length #35 Chain w/Connecting Link	1
27	Motor	1
28	5/16 - 18 x 1" Hex Head Cap Screw with Washer & Nut	4
29	Special Spacers	10
30	3/8 - 16 Hex Nut	11
31	3/8 - 16 x 3/4 Slotted Cap Screw	1
32	3/8 - 16 x 3/4 Spinlock Bolt	6
33	3/8 - 16 Spinlock Nut	6
34	5/16 - 18 x 3/4	4
35	3/8 - 16 x 3/4 Carriage Bolt	1
36	3/8 - 16 Spinlock Nut	10
37	3/8 - 16 x 3/4 Spinlock Bolt	10
38	3/8 - 16 Spinlock Nut	2
39	7/16 - 14 x 1-1/2	2
40	7/16 - 14 Hex Nut w/Lock Washer	2
41	7/16 - 14 x 1-1/4 Hex Bolt	1
42	7/16 - 14 x 1-1/2	2
43	7/16 - 14 Nut	2
44	Hand Crank	1

Form H-7111
2500-MW-9/75

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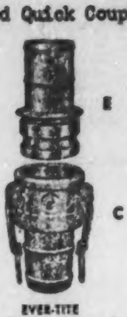
EVER-TITE Standard Quick Couplings - Screened copy for catalogs

EVER-TITE Standard Adapter and Coupler

EVER-TITE Adapter and Coupler

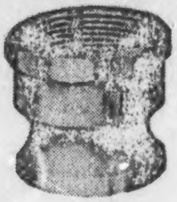


EVER-TITE Shank Adapter and Coupler

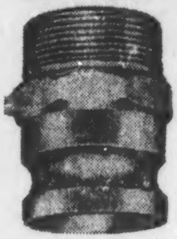
DP
Dust Plug
Dust Cap
DC

EVER-TITE Dust Protectors

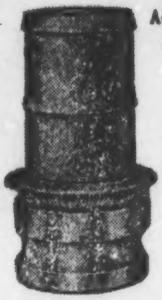
EVER-TITE Adapter and Coupler for Tank Car Unloading



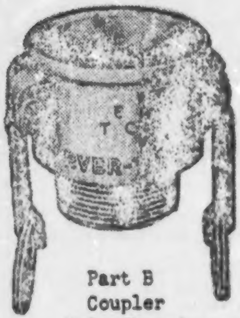
Part A
Adapter
Female Thread



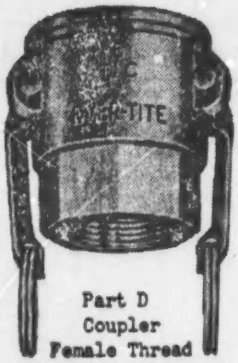
Part F
Adapter
Male Thread



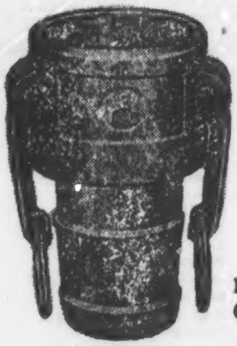
Part E
Adapter
Shank



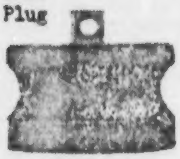
Part B
Coupler
Male Thread



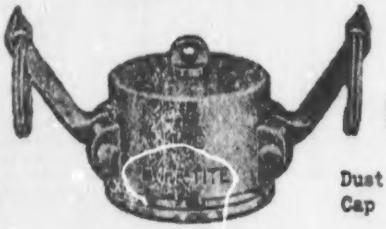
Part D
Coupler
Female Thread



Part C
Coupler
Shank



Dust Plug



Dust Cap

EVER-TITE COUPLING CO., INC.
254 West 54th St., N.Y., N.Y. 10019

Reprinted from catalog sheet with permission of Ever-Tite Coupling Co., Inc.

APPENDIX B. OPERATING MANUAL FOR GASOLINE-POWERED MODEL

Introduction

The MSA Emergency Collection System for Hazardous Spills is a portable device to be used in transferring contained spilled fluids into a holding bag which is part of the system.

The purpose of this manual is (1) to provide detailed instructions for operating the gasoline-powered emergency collection system for spilled hazardous materials and (2) to present information required for the proper servicing and maintenance of the equipment. A parts list is included.

General Description

The purpose of the Emergency Collection System is to pump spilled hazardous fluids into a connected group of large bags for temporary storage. The system consists, essentially, of a gasoline engine-powered pumping unit and 30 m (100 ft) of suction hose in addition to the folded collection bags and their housing. It is mounted on a 1.22 m x 1.67 m (4 ft x 5.5 ft) reinforced aluminum pallet. The bags can contain up to 26,500 ℓ (7000 gal) of spilled fluid. A single tankful of fuel will provide up to two hours of pumping time which in most cases should be sufficient time to nearly fill the bags. Additional pumping time may be obtained by refilling the fuel tank from the explosion-proof reserve tank.

A photograph and a layout diagram of the system are presented in Figures B-1 and B-2.

System Operation

Placing the System at the Spill Site--
Upon arrival at the site of the spill the most feasible location should be selected for placement of the system and deployment of the bag assembly.

Elevation relative to spill--The efficiency of the pump is determined primarily by the vertical distance between the mouth of the suction hose and the pump inlet port (head). The system should be placed as close as possible to or even below the elevation of the spill to be drained. Performance curve showing pumping rates as a function of head distance is presented in Figure B-3.

Space allowance for bag assembly--Sufficient space must be allowed to open the bag assembly once it is removed from its housing. The opened bag assembly requires an area measuring 8 m

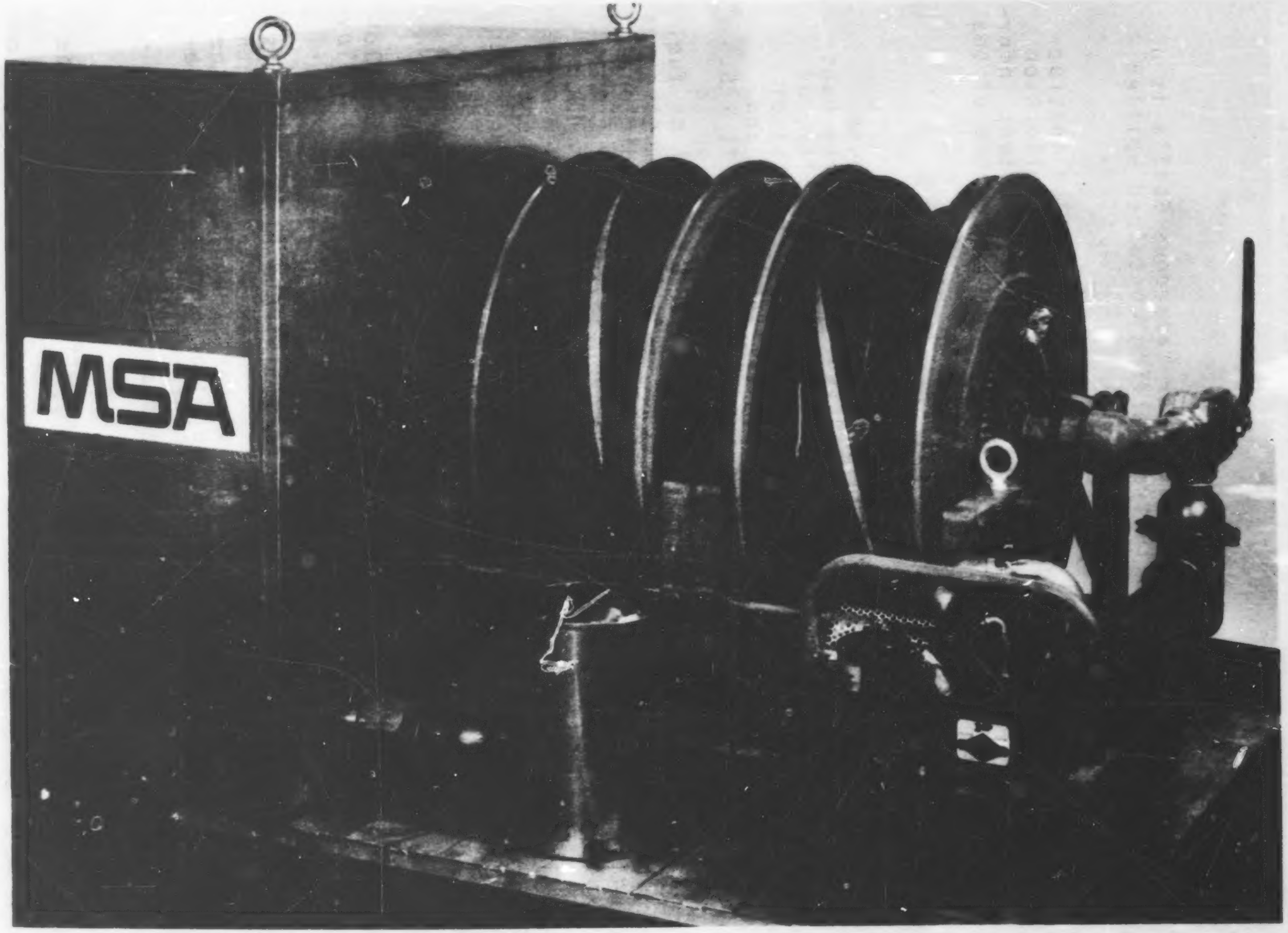
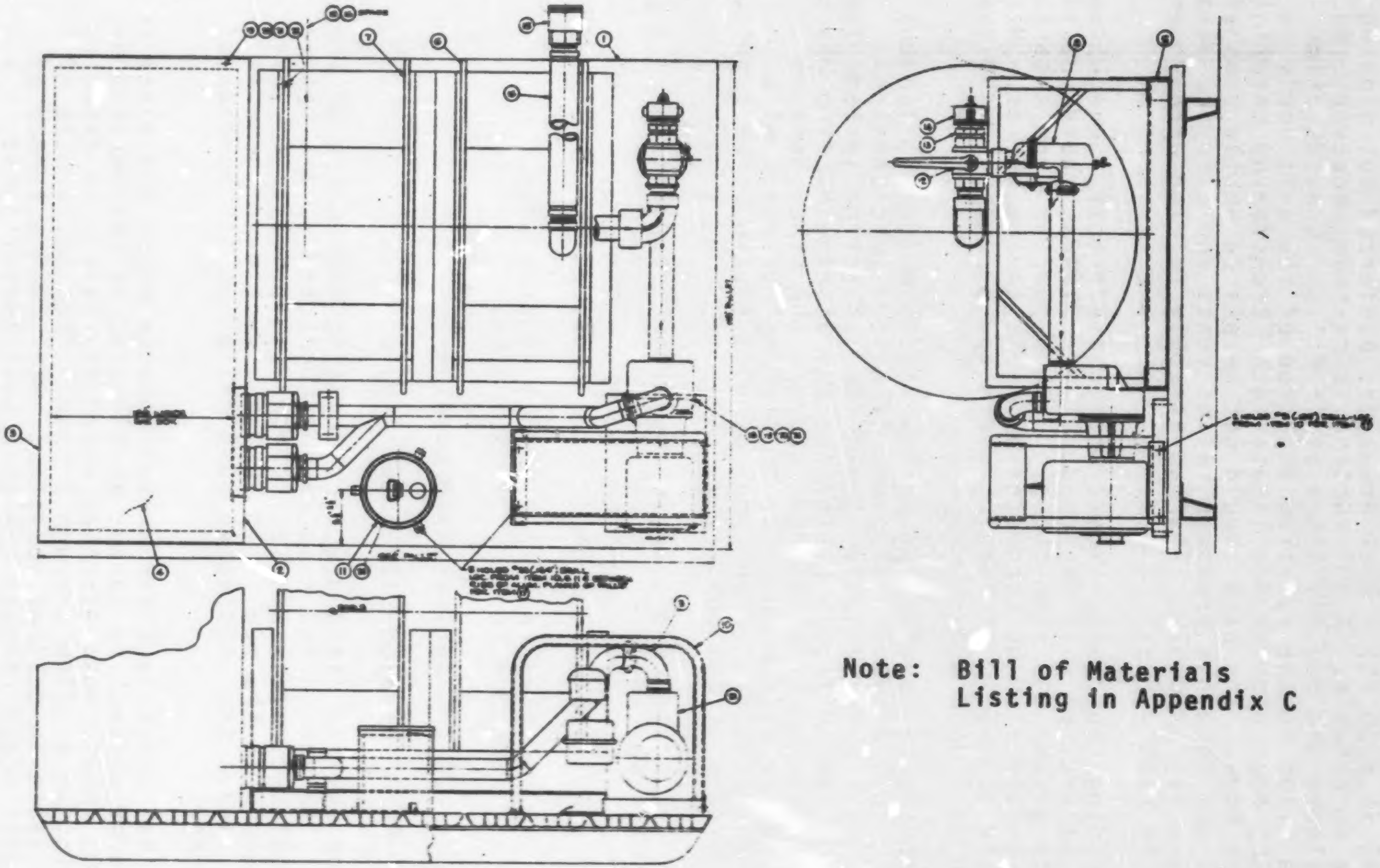


Figure B-1. Photograph of gasoline-powered model



Note: Bill of Materials
Listing in Appendix C

Figure B-2. Layout diagram of gasoline-powered model by 6 m (25 ft x 20 ft). Flat areas are preferred but sloping areas are acceptable. A 30° incline is maximum, however. On steeper slopes the bag may slide as it fills. Consideration should be given to the relative location of the exit ports on each of the four bags to facilitate later transfer of material out of the bags. The bags should not be placed upside down since this will put both the pressure relief vents and carrying straps beneath the bag assembly. The bag assembly folding arrangement is shown in Figure B-4.

Grounding the system--Where static electricity generation may be a hazard, as with low-conductivity fluids, cable should be used to ground the pump chassis. When pumping from a tanker, the pump should also be connected by cable to the tanker. Wire size should be AWG 10 or larger. Selected grounding techniques are shown in Figure B-5.

Deploying the suction hoses--Two 15.25 m (50 ft) lengths of 5 cm (2 in.) diameter, neoprene jacketed, acid-chemical transfer hoses are available aboard the collection system. The hose on the reel directly behind the bag storage housing may be completely removed from its reel whereas the other hose is attached to the rise connection of its reel by means of a threaded end-fitting. Five types of hose fittings are supplied with the system as follows:

1. A standard 5 cm (2 in.) thick coupling adapter.
2. A standard 5 cm (2 in.) coupler.
3. A standard 10 cm (4 in.) coupler with reducer to 5 cm (2 in.) pipe.
4. A cylindrical type strainer.
5. A beveled (45°) pipe nipple.

Select the desired fitting(s) and mount of the end(s) of the hose(s). The unattached hose may be connected to the system via the quick-coupling adapter located on the selector valve body adjacent to the reel. If only one section of hose is required, leave the unattached hose coiled on its portion of the hose reel.

Release reel crank lock and unreel hose or hoses and place in spill and/or connect to tanker as dictated by the particular situation. Avoid hose stresses which may result in crimping or restriction of flow through a hose. Then set handle of flow selector valve in desired position. With handle turned up pumping will occur through the hose reel swivel joint, i.e., from the attached suction hose. If down, pumping action is via

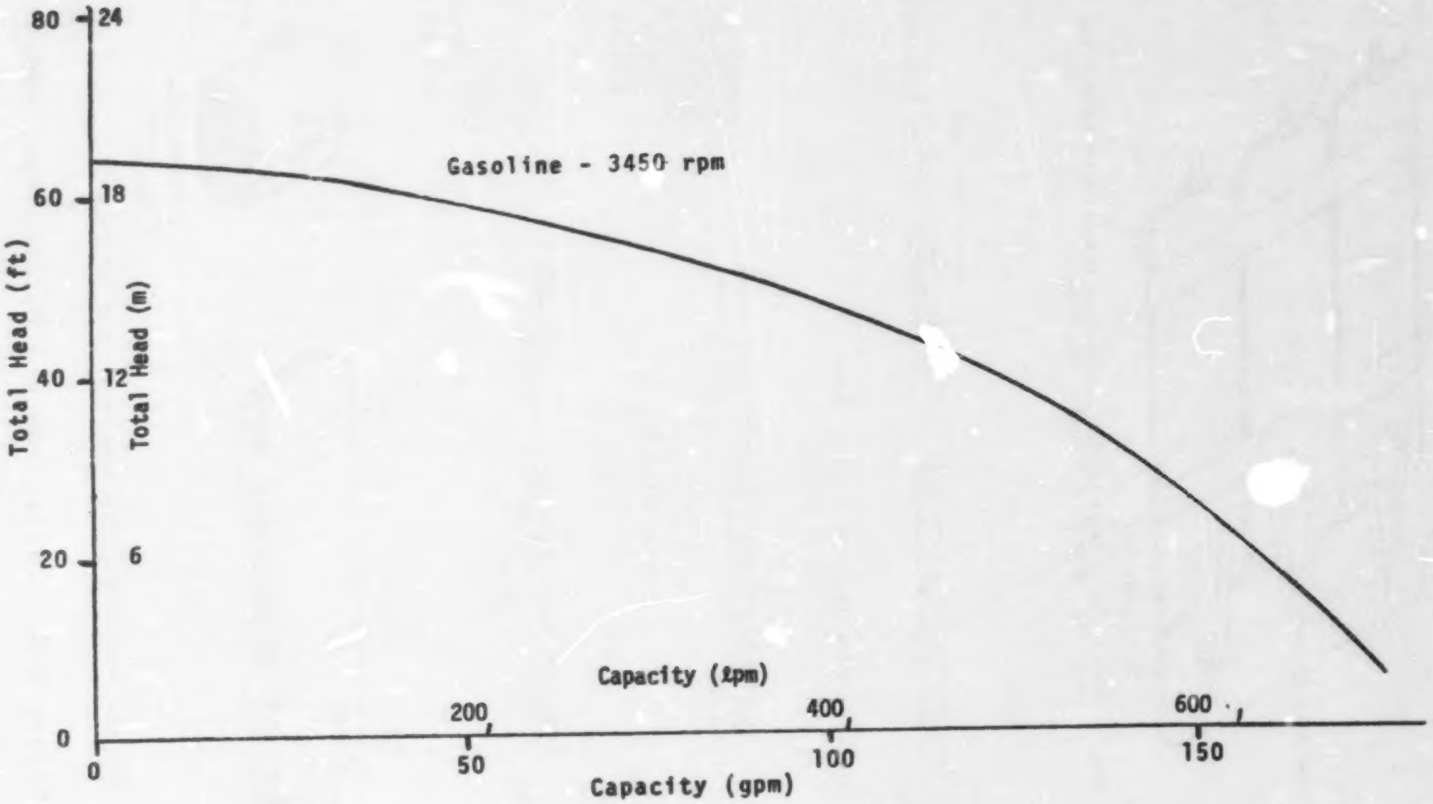
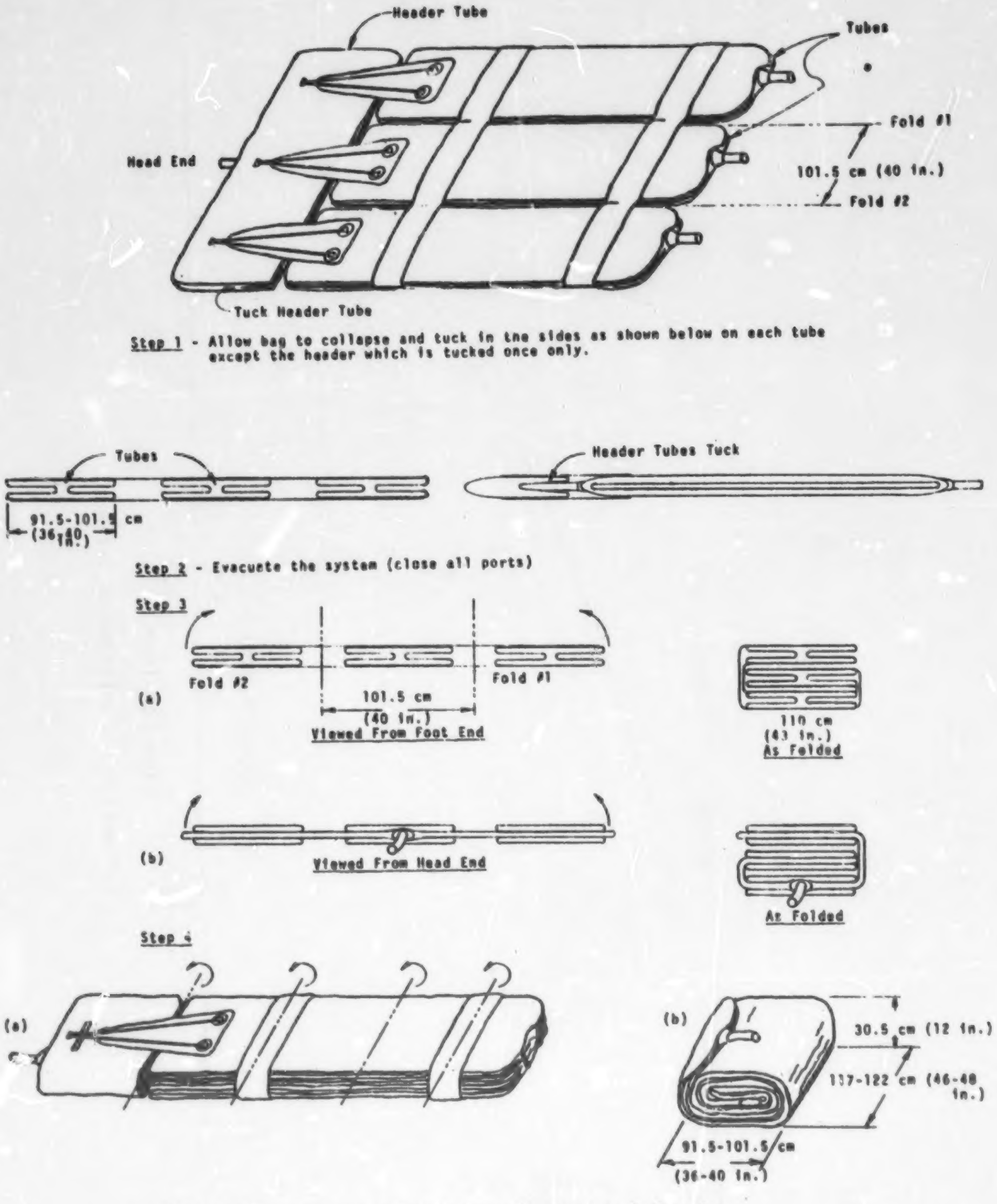


Figure B-3. Performance curve


Header Tube
Tubes
Fold #1
Head End
101.5 cm (40 in.)
Fold #2
Tuck Header Tube
Tubes
Header Tubes Tuck
91.5-101.5 cm
(36-40 in.)
Fold #2
Fold #1
(a)
101.5 cm
(40 in.)
Viewed From Foot End
110 cm
(43 in.)
As Folded
(b)
Viewed From Head End
As Folded
(a)
(b)
30.5 cm (12 in.)
117-122 cm (46-48 in.)
91.5-101.5 cm
(36-40 in.)

Step 1 - Allow bag to collapse and tuck in the sides as shown below on each tube except the header which is tucked once only.

Step 2 - Evacuate the system (close all ports)

Step 3

Step 4

Fold up as required to a 122x91.5x122 cm (48x40x48 in.) dimension

Figure B-4. Collection bag folding arrangement

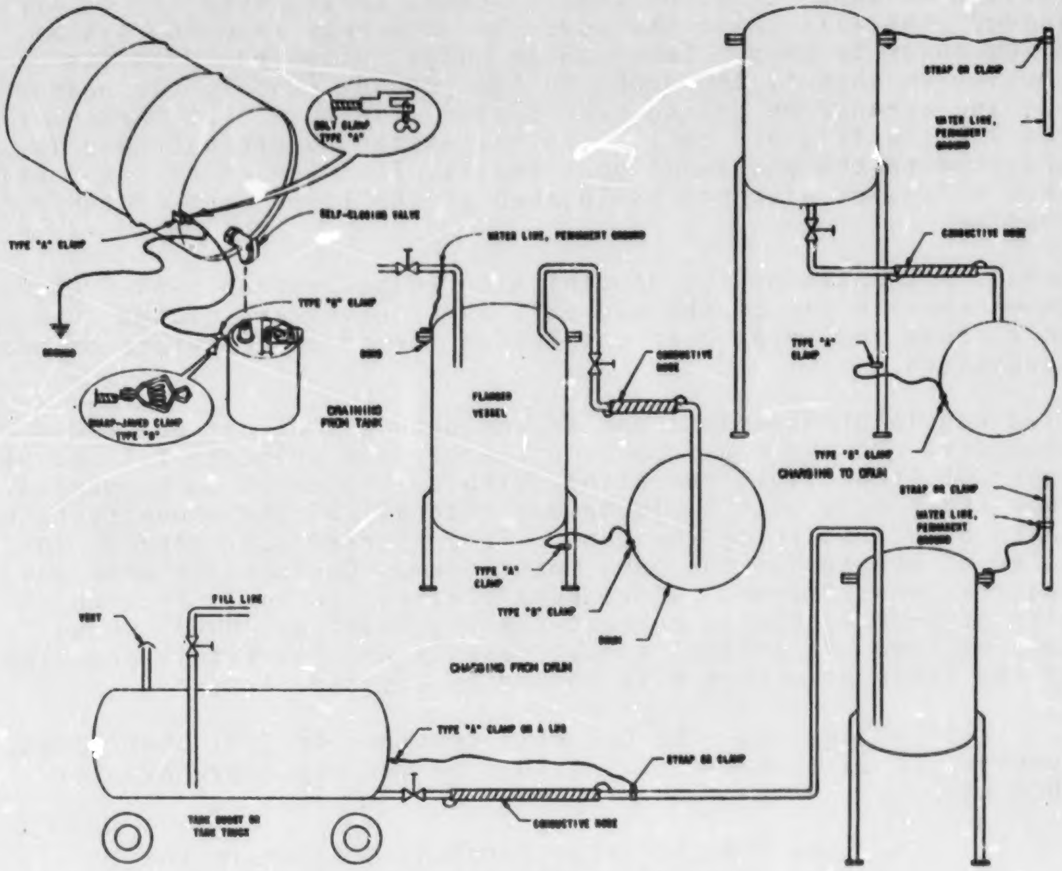

BOLT CLAMP
TYPE "A"
SELF-CLOSING VALVE
TYPE "A" CLAMP
GROUND
TYPE "B" CLAMP
SHARP-JAWED CLAMP
TYPE "B"
DRAINING
FROM TANK
WATER LINE, PERMANENT GROUND
BOND
FLANGED
VESSEL
CONDUCTIVE
HOSE
TYPE "A"
CLAMP
TYPE "B" CLAMP
DRUM
CHARGING FROM DRUM
STRAP OR CLAMP
WATER LINE,
PERMANENT
GROUND
CONDUCTIVE HOSE
TYPE "A"
CLAMP
TYPE "B" CLAMP
CHARGING TO DRUM
STRAP OR CLAMP
WATER LINE,
PERMANENT
GROUND
VENT
FILL LINE
TYPE "A" CLAMP ON A LUG
STRAP OR CLAMP
TANK WAGON OR
TANK TRUCK
CONDUCTIVE HOSE

Figure B-5. Grounding techniques

the port adjacent to the hose reel. If the handle is in a horizontal position pointing toward the pump side of the unit, pumping will occur from both ports (both hoses) simultaneously.

Deploying bag assembly and starting pump--Open the cover of the bag housing by pulling the tabs on the spring-loaded bolts, located at upper front of cover, inward toward each other. Spring loaded pins will cause the cover to drop away from the system. Allow cover to drop. Then gently nudge folded bag from its housing so that it too drops to the ground. Unfold the header bag and arrange on ground near system. Be sure that the end of the 3 m (10 ft), 3.8 cm (1.5 in.) diameter SS braided hose is attached to the bag inlet port and is within reach of the double shut off quick disconnects located at the lower rear of the bag housing.

Unfold and position the remaining three collection bags. Check to be certain all of the bag exit port valves are closed. Check inlet hose and inlet port connection for possible twists or constructions.

Plug bag inlet hose into one of the double shut off quick disconnects. Remove cap from pump chamber and prime by filling with water or other fluid compatible with the material to be pumped. Then start pump. It is important that all of the above steps be taken before starting the pump. Pump starter pull cord is located at the top of the pump motor frame. Choke adjustment may require repositioning before pump starts. Choke is located at side of engine housing nearest the bag housing. Note: When pumping from two points, simultaneously or alternately, pumping of the lower elevation site should be started first.

Filling the bag--The bag will continue to fill unattended, however, certain checks during this period may prove helpful, such as:

1. See that no large stresses develop in the bag material or its strap-anchors due to terrain features. A large rock or board support may relieve such a stress point.

2. Check closures on exit ports to insure against leaks.

Adding a second bag assembly--If a second bag assembly is required, its inlet hose may be connected to the second quick disconnect which is manifolded together with the first in the area just behind the bag housing. Do NOT disconnect first bag assembly without having a second bag connected unless pump motor is first stopped.

Extended pumping--The pump may be operated for longer time periods by transferring fuel from the explosion-proof can located next to the bag housing, adjacent to the pump.

Back-transfer from the bags--Each of the four bags in the system is equipped with two threaded ports to facilitate transfer of fluid from the bags (via the pump or gravity flow) to a permanent holding tank. Internal noncollapsing tubes which extend into the bag are attached to each port to prevent adjacent bag material from plugging the port.

NOTE: Sections of flexible hose should be connected to one port of each bag before filling operations begin to facilitate later back-transfer. These hose sections should terminate in a valve or other shut-off device. However, open-ended sections may be employed if the ends are pinched shut or maintained at an elevation higher than that of the liquid in the filling bag.

Clean-up after run--After system has been used to transfer a fluid to the collecting bags it should be flushed with water and/or solvent to remove traces of possibly-contaminant materials.

Trouble Shooting

Improper operation of the Emergency Collection System can occur due to several causes. The following instructions will be helpful in tracing the cause of a failure or improper system operation. Possible difficulties are listed in the sequence which they might be encountered in the course of operating the system.

A. Hose reel jammed:

- check crank locking wheel located at side of reel mount
- check for binding of hose(s) against a part of the system

B. Bag housing door will not open:

- probably due to twisting of the bag housing. Use screw driver or similar object to pry out top of door.

C. Pump will not start:

- reset choke, try again
- check spark plug

D. Starter rope jammed:

—— check for binding in rope recoil reel

—— possible foreign object(s) in pump

E. Starter rope will not rewind:

—— check spring in recoil reel

Maintenance

No general maintenance should be required other than to clean the hoses and pump lines after use. A repair kit for the bag is included with the system which contains various types of hose sealers. Maintenance on specific system components should be performed as directed by the supplier, or by returning the unit to the vendor for servicing.

A parts list which includes all components and major units is provided in Table B-1. Specific manual to be consulted are reproduced in the following catalog sheets.

Table B-1. PARTS LIST FOR GASOLINE-POWERED MODEL

Item	Description	Part No.	Required	Supplier
1	Fluid Bag, 2-ply urethane coated nylon	(Special)	1 ea	Holcombe Industries Industrial Covers Div.
2	Pump, close-coupled to explosion resistant B&S engine	1-1/2 HE19	1 ea	ITT Marlow Pump
3	Hose Reel, with 90° swivel joint, left top rewind, hand crank to rear, 90° riser, SS internals and swivel joint	8226-33-34	1 ea	C.B. Hannay & Son, Inc.
4	Hose Reel, storage	C-8226-33-34	1 ea	C.B. Hannay & Son, Inc.
5	Hose, Gatron, 5 cm (2 in.) dia x 15.25 m (50 ft) long section with fittings	45HW	2 ea	Gates Rubber Corp.
6	Hose, 3.8 cm (1.5 in.) dia x 3 m (10 ft) long, Titeflex, male NPT one end,stud other end	R-276	1 ea	Atlas Corp., Titeflex Div.
7	Strainer, basket only, to fit No. CS-15F-125, stainless steel (specify mesh size)	---	1 ea	Tate, Tempco, Inc.
8	Three-way ball valve, SS, 5 cm (2 in.) NPT ports, Teflon seals	5 cm (2 in.) 3227T	1 ea	Quality Control, Inc.
9	Quick disconnect socket, 5 cm (2 in.) NPT, SS, 2-way shut off	LL20-H51-143 SS	2 ea	Hansen Mfg. Co.
10	Quick disconnect plug, 5 cm (2 in.) NPT,	LL20-K51-	1 ea	Hansen Mfg. Co.
11	Explosion-proof dispensing can	8420B	1 ea	Protectoseal Co.

(continued)

Table B-1 (continued)

Item	Description	Part No.	Required	Supplier
12	5 cm (2 in.) quick coupling, SS	Type A	2 ea	Evertite Coupling Co.
13	Strainer, Brass, nickel plated	Special	1 ea	Mine Safety Appliances Co.

CAST IRON ENGINE-DRIVEN SELF-PRIMING CENTRIFUGAL PUMPS

MEDIUM HEAD

ENGINE
BRIGGS & STRATTON 8
3.0 hp @ 3600 rpm maximum rating

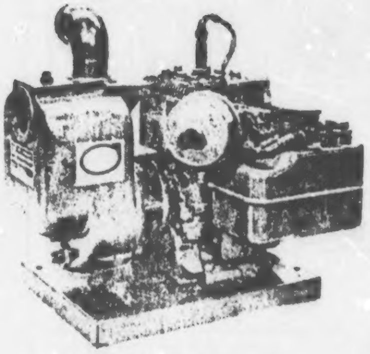
Continuous duty brake horsepower developed by each engine is approximately 20-25% less than the maximum rating.

STANDARD UNIT INCLUDES:

PUMP:
Exclusive diffuser-type priming system. Base mounted with lifting handle. Self-lubricating, stainless steel, Remite mechanical type seal. 1-1/2 H19 and 1-1/2 A1 models have 1-1/2" threaded female suction and discharge connections, 2 H19 and 2 A1 models have 2" threaded female suction and discharge connections. Suction line strainer and internal suction check valve included with 1-1/2 and 2 A1 models.

ENGINE:
All aluminum alloy "Kool Bore" construction. Air cooled by flywheel magneto for easier starting. Pneumatic type adjustable governor. Pulsa-jet carburetor rope start. Fitted with the following accessories to assure explosion-resistant operation.

- •Metallic shielded spark plug and ignition wiring.
- •Enclosed ignition switch to ground primary wiring.
- •Air filter with oil-wetted metallic element.
- •Centrifugal type spark arresting muffler.



1-1/2H19 & 2H19 Models Illustrated

SPECIFICATIONS

MODELS
1-1/2 A1
1-1/2 H19

DIMENSIONS and DATA		BASE MOUNTED 1-1/2H19 & 2H19	 1-1/2A1	 2A1
	Height (with engine)	16-1/2"	15-1/2"	
	Length (with engine)	15-3/4"	19-1/2"	
	Width (with engine)	13"	14"	
	Net Weight (approx.)	60 lbs.	80 lbs.	85 lbs.
	Shipping Weight (approx.)	70 lbs.	90 lbs.	95 lbs.
PUMP:	Shaft Seal	Self-lubricating, Remite, mechanical type 3/4"		
	Maximum Size Solids Handled	3/8"		
	Tank Capacity	2 Quarts		
	Tank Pressure Limit, PSI	200 lbs., PSI		
ENGINE:	Make, Model	Briggs & Stratton 8		
	No. of Cylinders & Displacement	1 cyl., 7.75 cu. in.		
	Fuel Capacity & Consumption	2Qt. 3.25 hr. per Gal. @3600 rpm full load		
	Starting Method	Rope Start		
	Ignition & Spark Plug Size	Flywheel magneto 14 mm		
	Valve seats	Sintered alloy inserts		
	Exhaust valves	Austenitic steel, positive valve rotator		
	Air Cleaner	Oil-wetted metallic element		
	Oil Reservoir	1-1/4 pints		
	Cooling Method & Capacity	Air Cooled		

MODELS
2A1
2H19

MARLOW PUMPS ITT
MIDLAND PARK, NEW JERSEY LONGVIEW, TEXAS
GUELPH, ONTARIO, CANADA PRINTED IN U.S.A.

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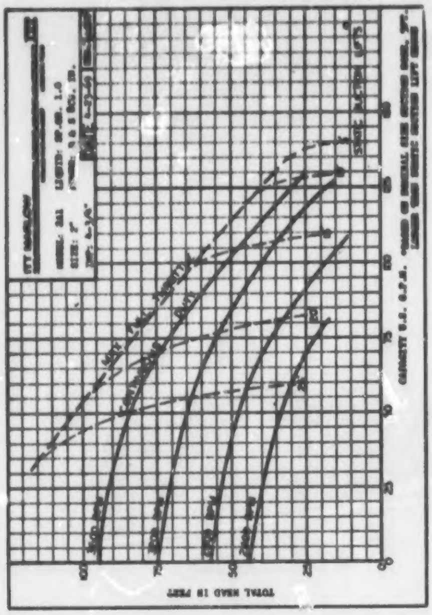
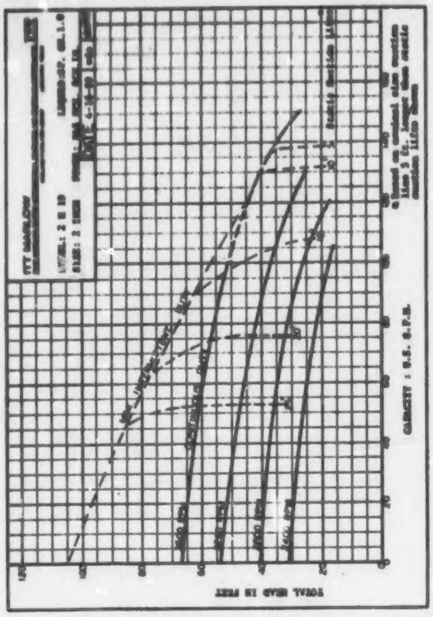
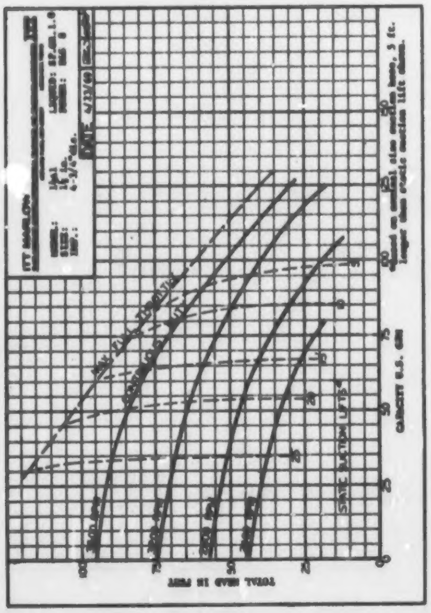
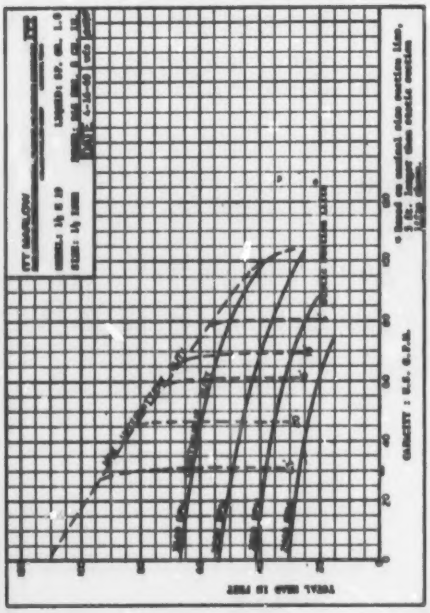
PERFORMANCE CURVES









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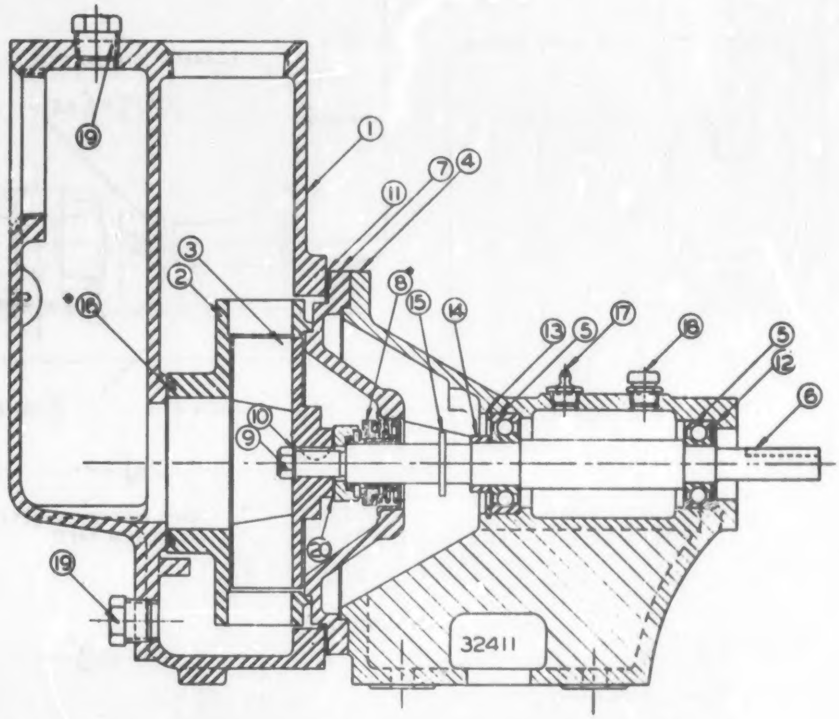
CROSS SECTION
Model 1-1/2HE19 Stainless Steel
SELF-PRIMING PUMPS



ITEM NO.	DESCRIPTION
1	Stainless Steel Tank, 2 quart capacity, 400 psi pressure limit
2	Stainless Steel Diffuser
3	Stainless Steel Impeller, 3-15/16" diameter, open type
4	C.I. Lantern Frame and Bearing Housing
5	Single Row, Double Shielded Ball Bearings
6	Stainless Steel Shaft
7	Stainless Steel Seal Plate
8	Remite® Mech. Shaft Seal, 5/8", Teflon Parts*
9	Stainless Steel Impeller Nut
10	Stainless Steel Impeller Washer
11	Gasket (Compound)
12	Spring Steel Finger Spring
13	Steel Bearing Retaining Ring
14	Steel Bearing Lock Collar
15	Slinger (Vyflex)
16	Gasket "O" Ring, Teflon*
17	1/8" Alemite Grease Fitting
18	1/8" Alemite Relief Fitting
19	3/8" N.P.T. Stainless Steel Tank Plug
20	Stainless Steel Impeller Shims

*ALSO AVAILABLE IN BUNA N

5-72

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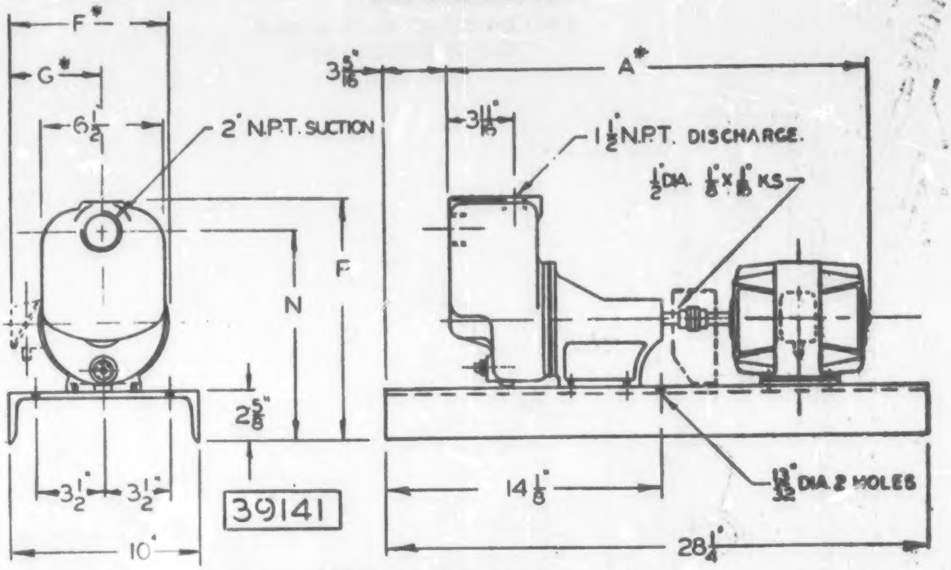
DIMENSIONS

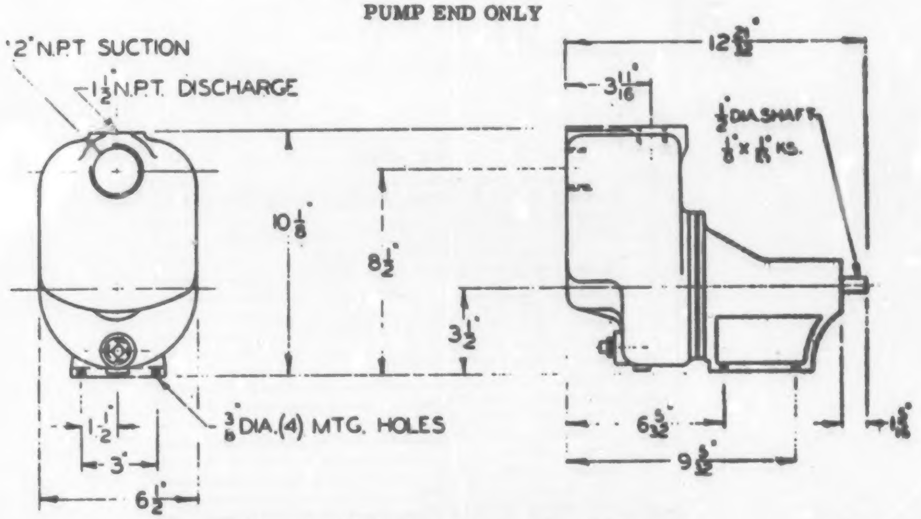
MODEL 1-1/2HE19EL-BASE MOUNTED
Long Coupled Pump


F*
G*
6 1/2
2" N.P.T. SUCTION
3 5/16
A*
3 11/16
1 1/2" N.P.T. DISCHARGE.
1/2" DIA. 1/8" x 1/16" KS
F
N
2 5/8"
3 1/2"
3 1/2"
39141
10"
14 1/8"
13/32" DIA 2 HOLES
28 1/4"

MOTOR FRAME	A*	N	P	F*	G*
56, 143T, 145T	24 7/8	11 1/8	12 3/4	9 1/2	6
182T, 184T	28 1/4	12 1/8	13 3/4	12 1/8	7 3/4

*DIM'S MAY VARY DEPENDING ON MOTOR MFR.

PUMP END ONLY


2" N.P.T. SUCTION
1 1/2" N.P.T. DISCHARGE
12 21/32"
3 11/16"
1/2" DIA SHAFT
1/8" x 1/16" KS.
10 1/8"
8 1/2"
3 1/2"
1 1/2"
3"
3/8" DIA. (4) MTG. HOLES
6 1/2"
6 5/32"
9 5/32"
1 5/16"

THESE DIMENSIONS NOT TO BE USED FOR CONSTRUCTION PURPOSES UNLESS CERTIFIED.

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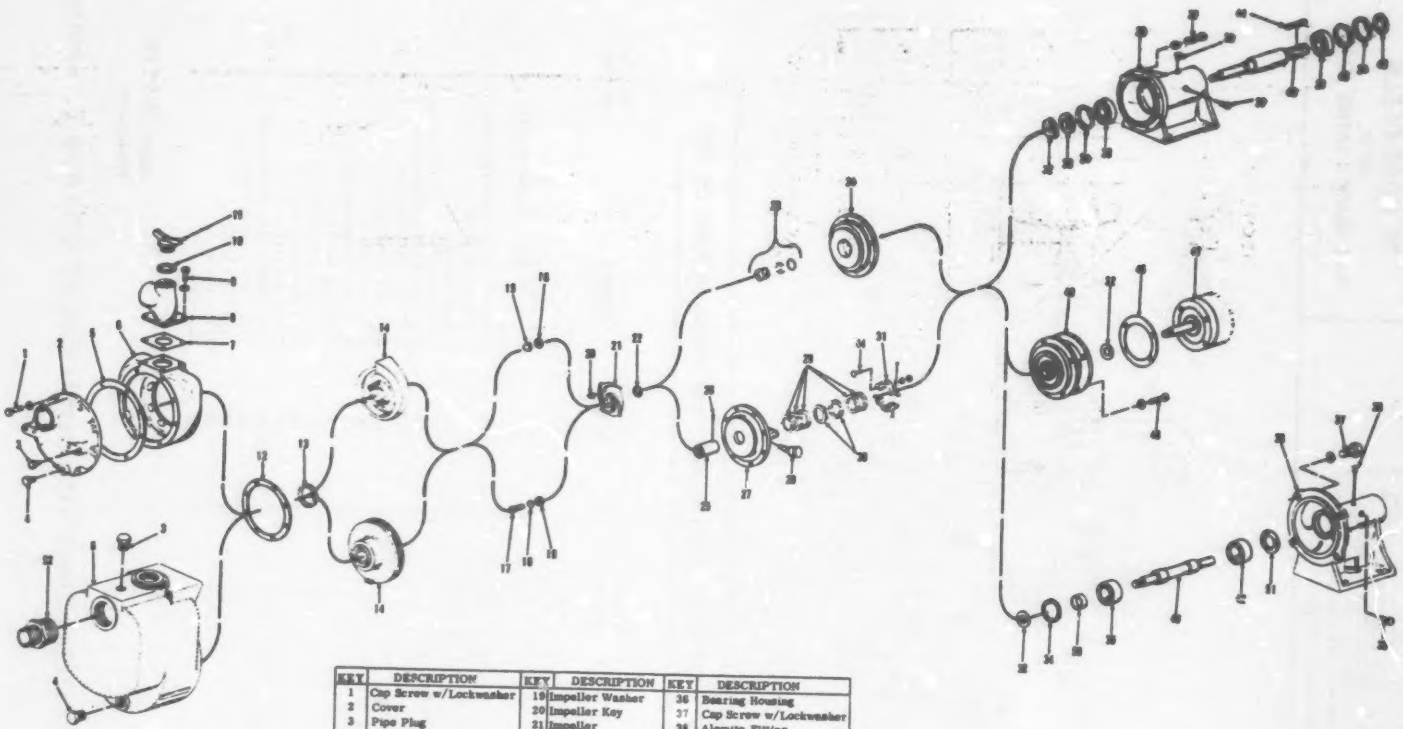

KEY	DESCRIPTION	KEY	DESCRIPTION	KEY	DESCRIPTION
1	Cap Screw w/Lockwasher	19	Impeller Washer	36	Bearing Housing
2	Cover	20	Impeller Key	37	Cap Screw w/Lockwasher
3	Pipe Plug	21	Impeller	38	Alemite Fitting
4	Pipe Plug	22	Impeller Shim	39	Plug or Relief Fitting
5	Gasket, Cover	23	Seal Assembly	40	Shaft
6	Tank	24	Seal Plate	41	Key, Input
7	Gasket, Discharge	25	Shaft Sleeve	42	Ball Bearing
8	Discharge Tee	26	Sleeve Lock Pin	43	Bearing Shim
9	Cap Screw w/Lockwasher	27	Packing Plate	44	Carriage Bolt
10	Gasket, Filler	28	Grease Cup	45	Bearing Cap
11	Filler Plug	29	Packing, Set	46	Lantern Shim
12	Gasket, Tank	30	Grease Rings, Pair	47	Motor
13	Gasket, Diffuser	31	Gland Assembly	48	Cap Screw w/Lockwasher
14	Diffuser	32	Slinger	49	Lantern
15	Impeller Nut	33	Bearing Cap	50	Bearing Spacer
16	Impeller Washer	34	Retaining Ring	51	Finger Spring
17	Impeller Lock Screw	35	Ball Bearing	52	Adapter or Reducer
18	Impeller Lockwasher				

35624-3

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IMPORTANT: How to USE this DRAWING to ORDER PARTS

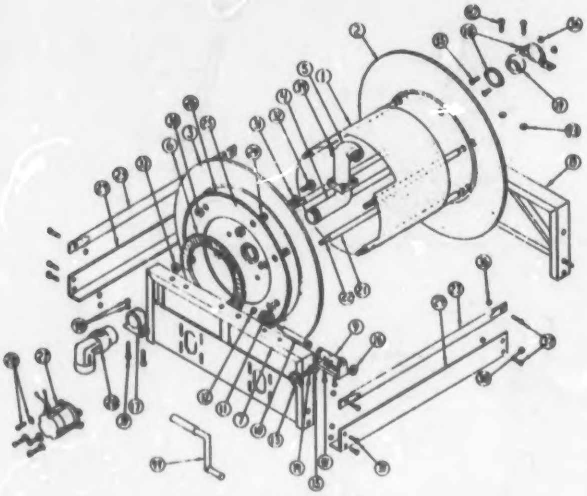
The above grouping of parts illustrations cover many different Marlow models, including your own pump. The table on the left page indicates the name of each part. Should you need a replacement, refer to above drawings - locate the part that matches your pump part. Contact your local Marlow dealer and supply him with the Key Number and Description of the parts required, along with your pump Model number, Spec number and Serial number, which are located on the pump nameplate.

HANNAY REELS

CLIFFORD B. HANNAY & SON, INC., WESTERLO, NEW YORK 12193
TELEPHONE (518) 797-3791

PARTS LIST
2" HOSE REELS
WITH
BALL BEARING SWIVEL JOINT

Drawing ISO-35



When ordering parts,
BE SURE TO SPECIFY COMPLETE MODEL NUMBER and SERIAL NUMBER OF REEL

Drawing Number	Description	Quantity Required
1	Drum	1
2	Back Disc	1
3	Front Disc	1
4	Hub	1
5	Riser	1
6	Ring Gear H-28	1
7	Front Frame with Motor Mount	1
8	Back Frame	1
9	H-2A Side Pinion Bearing	1
10	Pinion Shaft	1
11	Pinion Gear H-29	1
12	Lock Nut	1
13	Brake Wheel H-30A	1
14	Brake Spring H-31	1
15	Brake Pad H-3	1
16	Collar & Set Screw	1
17	Front Bearing H-42	1
18	Bearing Holder	1
19	Self-aligning Bearing	1
20	2" Swivel Joint	1
21	Spacer Pipe	10
22	Carriage Bolt	10
23	Brace	2
24	Foot	2
25	Disc Sprocket	1
26	Length #35 Chain w/Connecting Link	1
27	Motor	1
28	5/16 - 18 x 1" Hex Head Cap Screw with Washer & Nut	4
29	Special Spacers	10
30	3/8 - 16 Hex Nut	11
31	3/8 - 16 x 3/4 Slotted Cap Screw	1
32	3/8 - 16 x 3/4 Spinlock Bolt	6
33	3/8 - 16 Spinlock Nut	6
34	5/16 - 18 x 3/4	4
35	3/8 - 16 x 3/4 Carriage Bolt	1
36	3/8 - 16 Spinlock Nut	10
37	3/8 - 16 x 3/4 Spinlock Bolt	10
38	3/8 - 16 Spinlock Nut	2
39	7/16 - 14 x 1-1/2	2
40	7/16 - 14 Hex Nut w/Lock Washer	2
41	7/16 - 14 x 1-1/4 Hex Bolt	1
42	7/16 - 14 x 1-1/2	2
43	7/16 - 14 Nut	2
44	Hand Crank	1

Form H-7111
2500-MW-9/75

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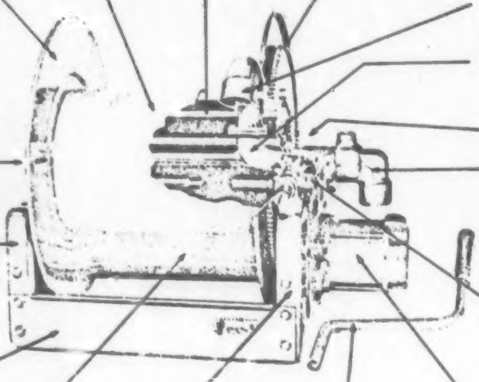
REEL COMPONENTS



TIE RODS
Join discs and drum to form spool. Reinforced with pipe spacers for rigidity and strength.

CHAIN & SPROCKET DRIVE
Provides smooth, positive rewinding

HUB ASSEMBLY –
Includes the fluid hub, the outlet riser and the reel axle. Fluid passes from the swivel joint inlet, through the hub assembly, to the hose.

DRUM
Roll-formed steel with full length weld.

DISC
Rolled edges prevent hose damage and add rigidity to disc. Additional strength is provided by a concentric rib.

OUTLET RISER
Contoured to match the curve of the reel drum so hose will wrap smoothly.

BEARINGS –
Weight of spool and hose is supported by bearings.

FLUID HUB

BACK BEARING

FRONT BEARING

SWIVEL JOINT INLET
Permits reel to rotate freely while connected to the fluid source. Joint is not used as a bearing. Straight or 90° swivel joints are available for most models.

BACK FRAME

BRAKE ASSEMBLY
Pinion shaft brake has adjustable tension to brake reel. Braking and locking devices vary with reel models.

FRONT FOOT

BACK FOOT

FRONT FRAME

REWIND CRANK
Supplied on reels equipped with crank rewind mechanism.

REWIND MOTOR
Electric rewind motor is shown. Compressed air or hydraulic motors can be used.

This cutaway illustration shows a typical power rewind reel with an auxiliary crank rewind mechanism. All Hannay reels are assembled from combinations of the basic components shown here. Since components are taken from a large inventory, each reel is, in effect, custom-assembled to the buyer's particular requirements.

GENERAL SPECIFICATIONS

CONSTRUCTION: Reel frames spool and fastenings are fabricated of heavy gauge steel. Malleable iron and steel are used as standard for swivel joint inlet, hub assembly and outlet riser. Stainless steel, aluminum, bronze and other alloys can be supplied to meet special requirements. Special packing materials for swivel joints are also available.

TEMPERATURE and PRESSURE: Standard reel construction will handle most liquids or gases at operating pressures to 600 p.s.i., and at temperatures from −20° to +225°F. Reels to operate at higher pressures or other temperatures can be furnished.

FINISH: Reels are painted in blue enamel as standard. Yellow or red enamel, or red oxide primer, are optional at no extra cost when specified. Other colors, primers and hot-dipped galvanized finish may be specified at extra cost.

SHIPPING: Reels are shipped completely assembled, ready to install. Installation instructions are supplied with each reel.

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EVER-TITE Standard Quick Couplings - Screened copy for catalogs

EVER-TITE
Standard Adapter
and Coupler

EVER-TITE
Adapter
and Coupler

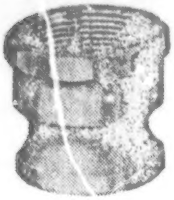
EVER-TITE
Shank Adapter
and Coupler

DP
Dust Plug
Dust Cap
DC

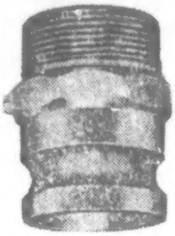
EVER-TITE
Dust Protectors

EVER-TITE
Adaptor and Coupler
for Tank Car Unloading

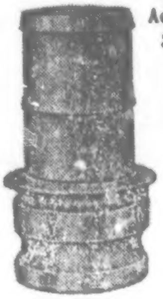
Part A
Adapter
Female Thread



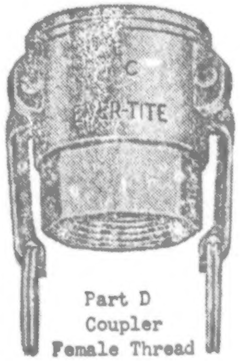
Part F
Adapter
Male Thread



Part E
Adapter
Shank



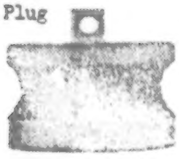
Part B
Coupler
Male Thread



Part D
Coupler
Female Thread

Part C
Coupler
Shank

Dust
Plug



Dust
Cap

EVER-TITE COUPLING CO., INC.
254 West 54th St., N.Y., N.Y. 10019

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APPENDIX C. BILL OF MATERIALS LISTING FOR BATTERY-POWERED AND GASOLINE-POWERED MODELS

BATTERY-POWERED MODEL (Figures 5 and A-2)

Item	Part No.	Req'd.	Description
1		1	Pump and motor assembly
2	B/C-3062	1	Reel assembly
3	3580-A	1	Battery carriage, pump and motor support
4		12	Gel/cell rechargeable battery
5	3581-A	1	Special pallet
6	3584-A	1	Box assembly
7	3583-A	1	Door assembly
8	3061-B	1	Door locking mechanism
9	A/C-3062	1	Special 180° return
10		1	Power supply (not shown)
11		1	Starter
12		2	1 1/2" quick disconnect
13		1	2" 3 way valve
14		3	2" 90° st. elbow
15		2	2" union
16		1	2" filter
17		3	2" 90° elbow
18		1	2" 45° elbow
19		1	1 1/2" 90° st. elbow
20		2	1 1/2" 90° elbow
21		1	1 1/2" 45° elbow
22		1	1 1/2" 2000# lateral
23		1	1 1/2" union
24		1	1 1/2" close nipple
25		2	1 1/2" pipe nipple, SS, 2 1/2" long
26		1	1 1/2" pipe nipple, SS, 4" long
27		1	1 1/2" pipe nipple, SS, 6" long
28		1	1 1/2" pipe nipple, SS, 8" long
29		1	1 1/2" pipe nipple, SS, 16 3/8" long
30		1	2" pipe nipple, SS, 2 1/2" long
31			Deleted
32		2	2" pipe nipple, SS, 6" long
33		2	2" pipe nipple, SS, 8" long
34			Deleted
35		1	2" pipe nipple, SS, 9 5/8" long
36		1	2" pipe nipple, SS, 10" long
37		1	2" pipe nipple, 14" long
38		4	Cap scr., Hex. HD, 1/2"-13x1 1/4" long, Stl.
39		4	Nut, Hex., 1/2"-13, Stl.
40		4	Washer, Flat, 1/2", Stl.

BATTERY-POWERED MODEL (continued)

Item	Part No.	Req'd.	Description
41		4	Lockwasher, split, Stl.
42		10	Cap scr., Hex. Hd., 5/16"-18x1 1/4" lg., Stl.
43		10	Nut, Hex., 5/16"-18, Stl.
44		10	Lockwasher, Split, 5/16"
45		2	2" pipe nipplex5" lg., SS
46		1	Clamp
47		1	Bracket
48		1	Bracket
49		1	Bracket
50		1	Bracket
51		1	Bracket

GASOLINE-POWERED MODEL (Figures 7 and B-2)

1	C-3072	1	Pallet
2	D-3598	1	Box assembly
3	C-3071	1	Door assembly
4	C-3077	1	Fluid bag
5	C-3073	1	Reel base
6	1/B-3044	1	Reel
7	2/B-3044	1	Reel
8	C-3067	1	Strainer assembly
9	B-3046	1	Piping assembly
10	C-3090	1	Guard
11	A-3304	1	Holder, primer can
12		1	3 way ball valve, 2" size, 316 SS body, cap & rotor, Teflon "O" rings,
13		1	2" adapter, medium thread, Part "F"
14		1	2" dust cap
15		2	2" coupler, fine thread, Part "D"
16		2	Hose, Gatron 45 HW, 2"x50' lg., end fittings, male 2" NPT attached to wire helix
17		7	#10x1/2" pan hd., type "B" blunt, self tapping sheet metal screw, Cad. plate Stl. or 18-8 SS
18		4	Cap screw, Hex. Hd., 5/16"-18, Cad. plate, Stl.
19		19	Nut, Hex., 5/16"-18, Cad. plate, Stl.
20		19	Washer, flat, 5/16", Cad. plate, Stl.
22		15	Cap screw, Hex. Hd., 5/16"-18, Cad. plate, Stl.
23		1	Centrifugal pump,self priming, med. with 3 HP @3600 rpm gasoline engine, explosion resistant operation
24		1	1 gal. straight side tight head pail, 26 Ga,7 19/32" high x 6 1/2" ID